SE 2 ABS

INSTRUCTION MANUAL

OSCILLOSCOPE

SS-5711D

IWATSU

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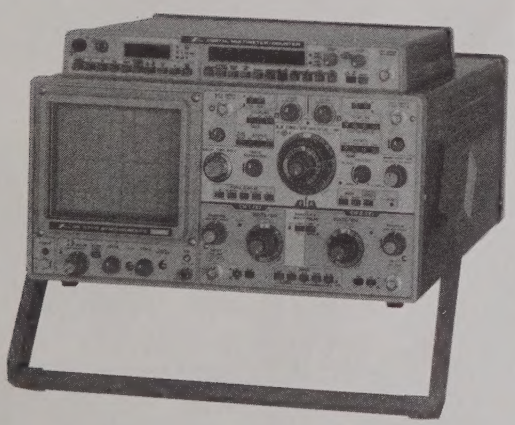

INSTRUCTION MANUAL

OSCILLOSCOPE

SS-5711D

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NOTES

Specification

1-1 GENERAL

The SS-5711D is an oscilloscope with a frequency bandwidth of DC to 100 MHz that can display 8 traces on 4 channels.

The SS-5711D is useful in a wide range of applications for not only production lines and maintenance and service purposes but also for the research and development of a variety of electronic devices. The features of the SS-5711D are as follows:

- In addition to display of 8 traces on 4 channels, the SS-5711D has an ADD function for measuring the sum of two signals and CH 2 POLAR for measurement of the difference between two signals.
- Both CH 1 and CH 2 have a high deflection factor of 1 mV/div (in the x5 MAG function), which permits accurate measurement of voltages.
- The horizontal deflection system has sweep rates up to 2 nsec/div (in the x10 MAG function) so that even high-speed phenomena can be measured with accuracy.
- The SS-5711D has delayed sweep, signle sweep, ALT sweep, and X-Y operation functions, and a TV synchronizing signal separator circuit so that television and other composite video signal waveforms can be observed.
- Inclusion of a universal counter enables direct reading of the frequency, period, time interval, delay time, and A EVENT IN DELAY TIME etc., of the signal being monitored.
- Signals are applied directly to the universal counter for period and frequency measurements.
- Inclusion of a digital multimeter enables direct measuring of DC and AC voltage, current, and resistance.

1-2 ELECTRICAL SPECIFICATIONS

1-2-1 Cathode-Ray Tube (CRT)

Shape	Rectangular, 6 inches
Display Area	8 div x 10 div (1 div=10 mm), with internal illuminated graticule of parallax-free type
Phosphor	B31 (Standard)
Accelerating Voltage	Approximately 20 kV

1-2-2 Vertical Deflection System

Modes	CH1, CH2, ALT, CHOP, ADD, QUAD (Quadruple) CHOP switching rate: 500 kHz ± 40%

Channels 1 and 2

Deflection Factor	5 mV/div to 5 V/div, in 10 calibrated steps in a 1-2-5 sequence Acceracy: ±2% (at 10°C to 35°C) ±5% (at −10°C to +50°C) 5 mV/div to 12.5 V/div continuously variable with the VARIABLE control x5 MAG: 1 mV/div to 1 V/div, in 10 calibrated steps Accuracy: ±4% (at 10°C to 35°C) ±8% (at −10°C to +50°C)

Frequency Response
DC to 100 MHz, −3 dB
(5 mV/div to 2 V/div)
DC to 50 MHz, −3 dB
(1 mV/div, 2 mV/div;
x5 MAG)
DC to 100 MHz, −3.5 dB
(5 V/div)
Notes
• 10°C to 35°C
• When the BANDWIDTH switch is pushed, the highest usable frequency become 20 MHz.
• AC coupling: The lowest Usable frequency is 4 Hz.

Rise Time
3.5 nsec (at 10 mV/div) or less

Pulse Response
Overshoot: 3%
Sag (at 1 kHz): 1%
Other distortion: 2%
(10 mV/div, 10°C to 35°C)

Signal Delay
Delay cable supplied

Input Coupling
AC, DC, GND

Input RC
Direct:
1 MΩ±1.5%//25 pF±2 pF
With probe:
10 MΩ±2%//14 pF±2 pF

Maximum Input Voltage
Direct:
250 V (DC + peak AC)
With probe:
600 V (DC + peak AC)
(Refer to the instruction manual for the probe for the maximum input voltage where the probe is used.)

Drift
0.1 div/hour or 2 mV/hour, whichever is larger, 30 minutes after power is turned on. (Standard)

Common Mode Rejection Ratio
At 10 mV/div
50 : 1 (1 kHz sine wave)
15 : 1 (20 MHz sine wave)

Polarity Inversion
CH 2 only

Channel 3 and 4

Deflection Factor
0.1 V/div, 1V/div, selectable
Accuracy:
±4% (at 10°C to 35°C)
±8% (at -10°C to +50°C)

Frequency Response
DC to 100 MHz -3 dB
(0.1 V/div)
DC to 100 MHz -3.5 dB
(1V/div)
Notes
• 10°C to 35°C
• Bandwidth: The highest usable frequency is 20 MHz.
• AC coupling: The lowest usable frequency is 4 Hz.

Pulse Response
As shown in table 1-1.

Table 1-1 (at 10°C to 35°C)

Waveform Distortion	0.1 V/div	1 V/div
Overshoot	7%	10%
Sag (at 1 kHz)	2%	2%
Other distortion	5%	5%

Input Coupling
AC, DC

Input RC
Direct:
1 MΩ±1.5%//27 pF±3 pF
With probe:
10 MΩ±2%//14 pF±2 pF

Maximum Input Voltage
Direct:
250 V (DC + peak AC)
With probe:
600 V (DC + peak AC)

1-2-3 Triggering

A-Triggering

Triggering Mode	AUTO, NORM SINGLE/ RESET
Signal Sources	CH 1, CH 2, CH 3, LINE, NORM (External trigger can be used by selecting CH 3 with SOURCE switch)
Coupling	AC, DC, HF REJ, LF REJ, FIX, TV-H, TV-V
Slope	Positive-going (+), Negative-going (-)

Minimum Trigger Sensitivity

As shown in table 1-2

Table 1-2 (at -10°C to 35°C)

Frequency	Sensitivity of CH 1, CH 2, CH 3, CH 4
DC to 10 MHz	0.3 div
10 MHz to 50 MHz	1 div
50 MHz to 100 MHz	1.5 div

Notes

• FIX:
1 div at 100 Hz to 10 MHz
2 div at 10 MHz to 50 MHz
Sine waves only

• TV-V, TV-H synchronizing signal level: 1 div or more on screen amplitude for a composite video signal composed of 7 parts video signal and 3 parts synchronizing signal

• Trigger signals are attenuated in the following frequency ranges depending on coupling
AC: 30 Hz or lower
HF REJ: 10 kHz or higher
LF REJ: 10 kHz or lower

• AUTO sweep mode: The lowest usable frequency is 50 Hz)

B-Triggering

Signal Sources	RUNS AFTER DELAY, CH 1, CH 2, CH 4 (External trigger can be used by selecting CH 4 with SOURCE switch.)
Coupling	AC, DC, HF REJ, FIX (AC)
Slope	Positive-going (+), negative-going (−)

Minimum Trigger Sensitivity

As shown in table 1-2

1-2-4 Horizontal Deflection System

Modes	A, A INTEN, ALT, B (DLY'D), X-Y

A-Sweep

Sweep Rates	20 nsec/div to 0.5 sec/div in 23 calibrated steps in a 1-2-5 sequence 20 nsec/div to 1.25 sec/div, countinuously variable with the VARIABLE control Accuracy I (Over center 8 divisions): ± 2% (at 10° C to 35° C) ± 4% (at -10° C to $+50^{\circ}$ C) Accuracy II (Over 2 of the center 8 divisions): ± 5% (at -10° C to $+50^{\circ}$ C)
Hold-Off Time	Variable with the HOLD OFF control

B-Sweep

Delay	Continuous delay (RUNS AFTER DELAY,) triggered delay

Sweep Rates	20 nsec/div to 50 msec/div, in 20 calibrated steps in a 1-2-5 sequence Accuracy I (Over center 8 divisions): ± 2% (at 10°C to 35°C) ±4% (at −10°C to +50°C) Accuracy II (Over any 2 of the center 8 divisions): ±5% (−10°C to +50°C)
Time Difference Measurement	0.2μ sec/div to 0.5 sec/div Accuracy: ±1% of reading ±0.01 graduation (Minimum graduation of DELAY TIME MULT dial)
Delay Jitter	1/20,000 or less
Sweep Magnification	10 times (Maximum sweep rate: 2 nsec/div) Accuracy I of magnified sweep rate (Over center 8 divisions): ±5% at 20 nsec/div, 50 nsec/div ±3% at 0.1 μsec/div to 0.5 sec/div (at 10°C to 35°C) Accuracy II of magnified sweep rate (Over any 2 of the center 8 divisions): ±10% at 20 nsec/div, 50 nsec/div ±6% at 0.1 μsec/div to 0.5 μsec/div ±5% at 1 μsec/div to 0.5 sec/div (at 10°C to 35°C) (Except 30 nsec from sweep start point and 40 nsec from sweep end point)

1-2-5 X-Y Operation

X Axis	(Same as CH 1 except for the following)
Deflection Factor	Same as that of CH 1 Accuracy: ±3% (at 10°C to 35°C) ±5% (at −10°C to +50°C)
Frequency Response	DC to 2 MHz, −3 dB
Y Axis	Same as CH 2
X-Y Phase Defference	3° or less (at DC to 100 kHz)

1-2-6 Z-Axis System

Sensitivity	0.5 Vp-p
Polarity	Positive (decleases intensity), negative (inclease intensity)
Frequency Range	DC to 5 MHz
Input Resistance	4.6 k Ω± 10%
Maximum Input Voltage	50 V (DC + peak AC)

1-2-7 Signal Outputs

Calibrator

Waveform	Square wave
Repetition Frequency	1 kHz Accuracy: ±1% (at 10°C to 35°C) ±2% (at −10°C to +50°C)
Duty Ratio	40% to 60%
Output Voltage	0.6 V Accuracy: ±1% (at 10°C to 35°C) ± 1.5% (at−10°C to +50°C)
Output Current	10 mA Accuracy: ±1% (at 10°C to 35°C) ±2% (at −10°C to +50°C)

CH 1 OUT

Output Voltage	40 mV ± 20% per div of amplitude on the CRT screen (at 50 Ω terminated)
Frequency Response	DC to 50 MHz, –3 dB
Output Resistance	50 Ω±20%

A Gate Out

Output Voltage	Approximately +5 V (Base line: Approximately 0 V)
Output Resistance	Approximately 2.7 kΩ

B Gate Out Same as A gate Out

1-2-8 Counter

Frequency measurement Measures A trigger signal

Range	LF mode: 0.1 Hz to 10 MHz HF mode: 1 MHz to 100 MHz (with 1/1000 prescaler)
Count time	0.01 sec, 0.1 sec, 1 sec, 10 sec
Measurement error	Base oscillator accuracy ±1 count

Period measurement Measures A trigger signal

Range	LF mode: 0.5 μsec to 10 sec HF mode: 10 nsec to 1 μsec (1000 periods or more)
Number of periods	LF mode: 10^0, 10^1, 10^2, 10^3 HF mode: 10^3, 10^4, 10^5, 10^6
Base time	0.1 μsec
Measurement error	Base oscillator accuracy $\pm\left(\frac{\pm\text{trigger error} \pm 0.1\ \mu\text{sec}}{\text{Number of periods}}\right)$
Minimum input Pulse width	LF mode: 0.25 μsec HF mode: 5 nsec

Time interval measurement Time interval of portion set on CRT with START, STOP cursor is measured.

Range	0.5 μsec to 10 sec
Base time	0.1 μsec
Measurement error	±(A sweep rate x 10 div x 3/1000)±0.2 μsec or less

Delay time measurement Delay time (A sweep start to B sweep start)

Range	0.5 μsec to 10 sec
Base time	0.1 μsec
Measurement error	±(A sweep rate x 10 div x 2/1000)±0.2 μsec or less

A EVENT IN DELAY TIME

	Number of A sweep trigger (A sweep start to B sweep start)
Count resolution	0.1 μsec
Minimum input pulse width	0.05 μsec
Maximum count	99,999,999
Count error	$\pm\left(\frac{\text{A sweep rate x 10 div x 2/1000}}{\text{period of A sweep trigger signal}}\right)\pm 1$ count

EXT INPUT Frequency and period of signals input from an external source may be measured in the HF mode.

Frequency range	1 MHz to 150 MHz (with 1/1000 prescaler)
Period range	6.7 nsec to 1 μsec (1000 periods or more)
Measurement error	Frequency: Base oscillator accuracy ± 1 count Period: Base oscillator accuracy $\pm\left(\frac{\text{trigger error} \pm 0.1\ \mu\text{sec}}{\text{measured frequency}}\right)$
Input voltage	0.1 Vrms to 2 Vrms
Input coupling	AC only
Input RC	Approximately 1MΩ//40 pF or less
Maximum input voltage	250 V (DC + peak AC)

General

Display	Zero-blanking, storage display with red LEDs, Non-storage display only with events in delay time.
Displayed digits	decimal 8 digits
Display time	Counted time + approximately 0.2 sec
Self-check	10 MHz (only with frequency measurement)
Read units	kHz, MHz, μsec, nsec displayed with 2 LEDs.
Alarm operation	Period measurement (LF mode only): 0.2 μsec to 0.4 μsec or less. Interval measurement, delay time measurement: 0.2 μsec to 0.4 μsec or less. The unit display LEDs blink for the input signals listed above.
Reset	Both automatic and manual (AC reset). When single operation time is measured with time interval measurement, the system is set in the wait status by pressing the reset button (since the interval is measure every second period).
Base oscillator	Oscillator frequency: 10,000 MHz Stability: $\pm 5 \times 10^{-7}$/Week Temperature stability: $\pm 10 \times 10^{-6}$/(0° to 40°C)

1-2-9 Digital Multimeter

DC Voltage Measurement

Table 1-3

Range	Accuracy (23°C ±5 °C, 80% RH or less)	Resolution	Input resistance
200mV	±0.25% of rdg ±0.05% of range	100μV	10 MΩ ±2%
2V		1mV	
20V		10mV	
200V		100mV	
1000V	±0.25% of rdg ±0.1% of range	1V	

rdg: Displayed value, range: Range value

Temperature coefficient	0°C to 18°C, 28°C to 50°C 200mV to 200V range: (±0.03% of rdg ±0.0075% of range)/°C 1000 V range (±0.03% of rdg ± 0.015% of range)/°C
Range select	Manual
C M R	100 dB or more 50/60Hz
N M R	40 dB or more 50/60 Hz
Maximum input voltage	±1,100 VDC

AC Voltage Measurement

Table 1-4

Range	Accuracy (23°C ± 5°C, 80%RH or less)	Resolution	Input resistance
200mV	±0.75% of rdg ±0.25% of range	100μV	10MΩ ±2%// 300 pF or less
2V		1mV	
20V		10mV	
200V		100mV	
750V	±10% of rdg ±0.4% of range	1V	

Display uses the average value rectification method
(actual value corrected)

Frequency range	40 Hz to 500 Hz
Temperature coefficient	0°C to 18°C, 28°C to 50°C 200 mV to 200 V range: (±0.01% of rdg ±0.02% of range)/°C 750V range: (±0.15% of rdg ±0.06% of range)/°C
Range select	Manual
Maximum input voltage	1,100 VDC or 750 Vrms

Resistance Measurement

Table 1-5

Range	Accuracy (23°C ± 5°C, 80% RH or less)	Resolution	Input current
200Ω	±0.25% of rdg±0.05% or range	100mΩ	1.9mA
2kΩ		1Ω	1.2mA
20kΩ		10Ω	0.25mA
200kΩ		100Ω	28μA
2000kΩ	±0.5% of rdg ±0.1% of range	1000Ω	2.8μA
20MΩ	±2% of rdg ±0.1% of range	10kΩ	0.28μA

Temperature coefficient	0°C to 18°C, 28°C to 50°C 200Ω to 200kΩ range: (±0.03% of rdg ±0.0075% of range)/°C 2000kΩ range: (±0.075% of rdg ±0.015% of range)/°C 20MΩ range: (±0.3% of rdg ±0.015% of range)/°C
Range select	Manual
Maximum voltage across terminals	3.5 V or less
Maximum input voltage	±400 VDC/rms

DC Current Measurement

Table 1-6

Range	Accuracy (23°C ± 5°C, 80% RH or less)	Resolution	Burden voltage
2mA	±0.8% of rdg ±0.05% of range	1μA	0.3 V or less
20mA		10μA	
200mA		100μA	
2000mA	±2% of rdg ±0.05% of range	1mA	0.7V or less

In case of 2A or more, protected by fuse.

Temperature coefficient	0°C to 18°C, 28°C to 50°C (±0.1% of rdg ±0.0075% of range)/°C

AC Current Measurement

Table 1-7

Range	Accuracy (23°C ± 5°C, 80% RH or less)	Resolution	Burden voltage
2mA	±2% of rdg ±0.25% of range	1μA	0.3 V or less
20mA		10μA	
200mA		100μA	
2000mA		1mA	0.7V or less

Display uses the average value rectification method (actual value corrected)
In case of 2A or more, protected by fuse.

Frequency range	40 Hz to 500 Hz
Temperature coefficient	0°C to 18°C, 28°C to 50°C (±0.3% of rdg ±0.02% of range)/°C

General

Display	Static display with 4 x 8 red LEDs
Maximum displayed	1999 or −1999
Operation	Drift compensation integration
Polarity	Automatic switching
Units	mV, V, Ω, kΩ, MΩ, mA displayed with 3 LEDs.
Range exceeded indication	Highest digit 1 or −1
Range select	Manual
Sample time	Approximately 400 msec/cycle

1-2-10 Power Supply

Voltage Range	100 V (90 to 110 V)/ 115 V (103 to 128 V)/ 220 V (195 to 242 V)/ 230 V, 240 V (207 to 264 V) AC One of these voltage ranges can be selected with voltage selector plug.
Frequency range	50 to 400 Hz
Power consumption	Approximately 68 W (at 100 V AC)

1-3 PHYSICAL CHARACTERISTICS

Weight	Approximately 10.5 kg (Without panel cover and accessories bag)
Dimensions	320 ± 2 (W) x196 ± 2 (H) x400 ± 2 (L) (mm) See Figure 1-1.

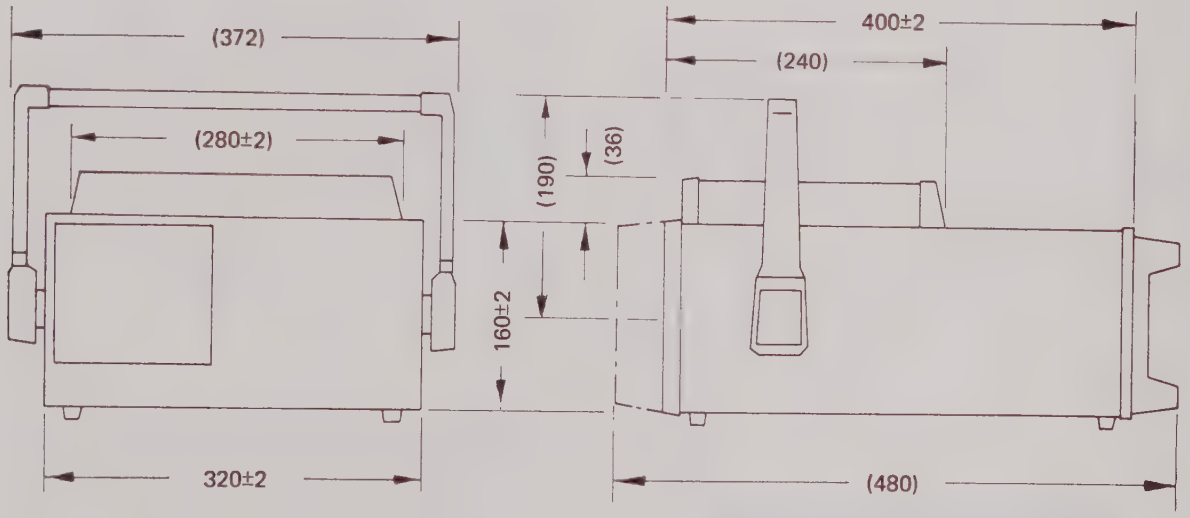
1-4 ENVIRONMENTAL CHARACTERISTICS

Operating temperature	−10°C to +50°C (oscilloscope) 0°C to 40°C (counter, digital multimeter)
Operating humidity	40°C, 90% relative humidity
Storage temperature	−20°C to +70°C
Storage humidity	70°C, 80% relative humidity
Altitude	Operating: 5,000 m maximum (atmospheric pressure 428 mmHg) Non-operating: 15,000 m maximum (atmospheric pressure 87 mmHg)
Vibration	From 10 Hz to 55 Hz and back in 1 minute; double amplitude 0.63 mm; for 15 minutes each in vertical, horizontal, and longitudinal directions for a total of 45 minutes.
Impact	One side is raised to an elevation angle of 45° (10 cm maximum), and let fall on a piece of hard wood. Each side is put to this test 3 times.
Drop	A package ready for transportation is dropped from a height of 60 cm.

1-5 ACCESSORIES

Power Cord	1
Probe (SS-0012)	2
Coaxial Cable	1
Measurement Lead	1
Fuse (FSA-2)	2
Fuse (FSA-0.2)	2
Fuse (FSA-0.5)	2
Fuse (FRA-2)	2
Panel Cover	1
Dust Cover	1
Instruction Manual	1
Accessories Bag	1

Figure 1-1. Dimensional Diagram



Notes

Section 2

Operating Information

2-1 OPERATING PRECAUTIONS

Observe the following precautions in operating the SS-5711D.

Ambient temperature and ventilation

The SS-5711D operates normally in the ambient temperature range of −10 °C to +50 °C. Be sure to use the SS-5711D within this range. Use of it outrange can result in some trouble. Do not place anything near the ventilating hole in the cover to block heat dissipation.

Line voltage check

Before plugging the power cord to an electrical output, be sure to check its voltage. The SS-5711D can be used on the line voltage shown in Table 2-1, which can be selected with the voltage selector plug on the rear panel. Also check the fuse in the rear panel as shown in Table 2-1. Operating the SS-5711D on other than the specified voltages can result in breakdown.

Before changing the voltage selector plug, or replacing the fuse, be sure to unplug the power cord from the electrical outlet.

Table 2-1

Set Position	Center Voltage	Voltage Range	Fuse
A	100 V	90 to 110 V	2A slow-blow
B	115 V	103 to 128 V	
C	220 V	195 to 242 V	1A slow-blow
D	230/240 V	207 to 264 V	

Be sure to replace the fuses with the correct ones.

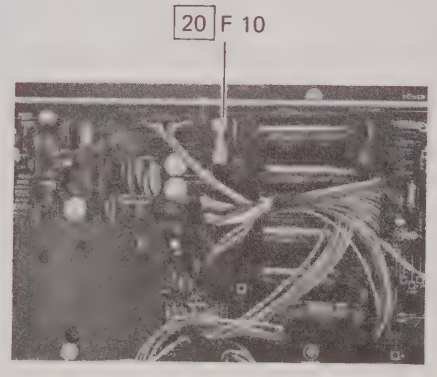
The SS-5711D uses the fuses shown in Table 2-2 to protect the circuits from damage by overcurrent.

If any of these fuses is burnt out, carefully determine the cause, repair a defect if any, and replace it with the correct one. Never use fuses other than specified because it can cause not only troubles but danger.

Table 2-2

Circuit No.	Fuse Spec.	Function	Position
13F01	2 A slow-blow	Voltage selector plug A or B	Rear panel see Figure 2-4.
	1 A slow-blow	Voltage selector plug C or D	
13F02	1A slow-blow	CRT circuit protection	See Figure 2-1.
4F001	0.2 A slow-blow	Counter circuit protection	See Figure 4-20.
1F101	0.5 A slow-blow	D.M.M circuit protection	See Figure 4-25.
1F102	2 A fast-blow	Current measurement circuit protection	See Figure 4-25.

Figure 2-1. Fuse Locations



Use the supplied power cord.

Use the supplied 3-core power cord.

When operating the SS-5711D on the line voltage form a 2-core electrical outlet with the supplied 3-core power cord and a conversion adaptor, be sure to ground the ground terminal on the rear panel to prevent danger.

Do not apply an excessively high input voltage.

Maximum voltage for each input is as follows (not apply a voltage higher than this.

CH1 • 2 • 3 • 4 INPUT	250V (DC + peak AC)
x 10 probe INPUT	600V (DC + peak AC)
Z AXIS INPUT	50V (DC + peak AC)
EXT INPUT 1M ~ 150MHz	250V (DC + peak AC)

Probes and input connectors.

Be sure to connect the probe ground leads and input connector ground terminals to the ground voltage part of the object to be measured. If they are connected to other point, the ground leads or terminals will be shorted through the SS-5711D, resulting in breakage of the measuring object or the SS-5711D (including its probes). This must be absolutely avoided.

Do not increase light intensity excessively

Do not increase the light intensity of traces or spot more than necessary. Excessive light intensity can not only result in eyes fatigue but, if left for a long tiem, burn the CRT phosphor surface.

Using the SS-5711D with the CRT screen up

The SS-5711D can be used with the CRT screen up as shown in Figure 2-2 (a). Be careful not to bring the SS-5711D down by pulling hard the probes connected to the signal input connector.

Symbol Marks of Digital Multimeter

⚠ Warning

This symbol indicates that the user should refer to the manual before using the SS-5711D. The maximum voltage and current which may be applied to the terminals as shown below.

DC voltage measurement	± 1,100VDC
AC voltage measurement	± 1,100VDC or 750Vrms
Resistance measurement	± 400VDC/rms
DC current measurement	2A
AC current measurement	2A

Flash warning

This symbol indicates that a voltage of 1kV or more is applied to the terminal from in or outside the multimeter. When measuring high voltages, particular care should be taken to avoid electric shock.

LO Terminal

The LO terminal is floating (ie., not earthed) with a dielectric resistance to GND of ±500 VDC. To prevent danger to the user, it should therefore not be connected to the GND terminals of other measuring equipment while voltage is applied to it.

Noise

An unstable display, and increased measurement errors, will result if the multimeter is used near sources of electrical noise.

Function switch (V, A, Ω)

Always check the setting of the function switch before beginning measurement. Do not alter the setting of the function during measurement (while voltage is applied to the signal input terminals).

2-2 OPERATION OF THE HANDLE

The carrying-handle of the SS-5711D can be unlocked if the rotary part (root) of the handle is pushed inwards (in the arrow direction) as shown in Figure 2-2 (b).

If both the right and left ends are pushed, they can be unlocked together, and the handle can be turned as it is.

If the rotary part is released, the handle is automatically locked.

The handle can be positioned as desired for carrying (as shown in Figure 2-2 (b)) or as a stand for signal observation (as shown in Figure 2-2 (c)).

Fold the handle back as shown in Figure 2-2 (d), if possible, when storing the SS-5711D.

2-3 CONTROLS AND SWITCHES

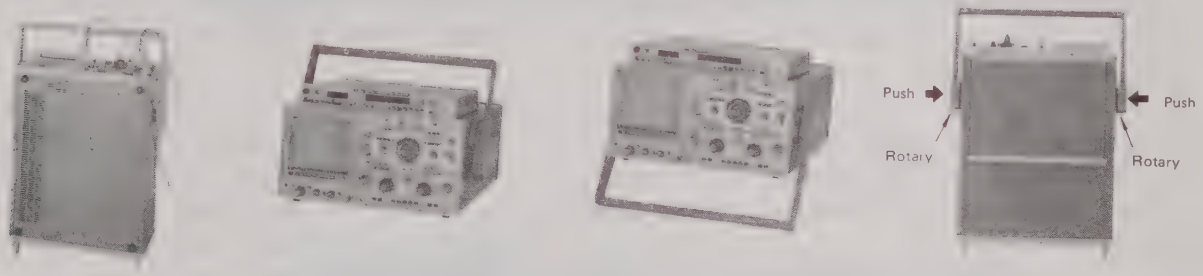
The function of the switches and controls on the front and rear panels are explained. Refer to Figure 2-3 to 2-9.

The front panel is color-coded. The power supply, CRT, and vertical deflection controls are dark-olive; trigger and horizontal deflection controls are light-olive.

If the VARIABLE controls for vertical deflection factor and sweep rate are set to other than the CAL position, the indicator lamp lights to indicate non-calibration.

In the description of the switches, the word IN indicate their pushed position (▬) and the word OUT their released position (▟).

Figure 2-2. How to Place and How to use the Handle



(a) (b) (c) (d)

Figure 2-3. Front Panel

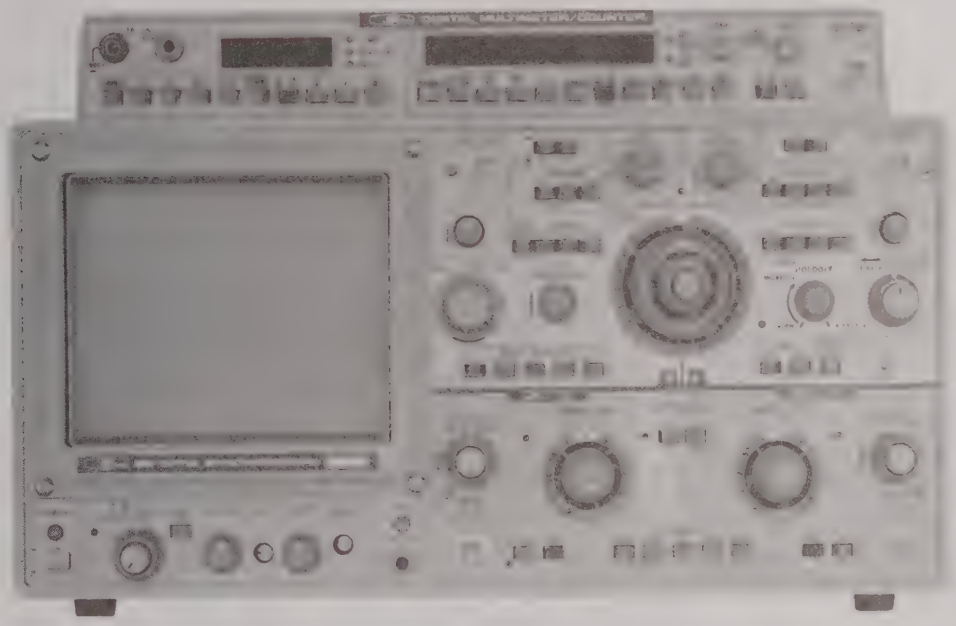


Figure 2-4. Rear Panel

2-3-1 Front Panel

Power, CRT and Calibration controls

POWER ON/OFF
Power switch

A INTEN (Slate-grey)
Adjust the brightness of traces or spot. Turning the control clockwise increases intensity, and turning it counterclockwise decreases intensiry.

B INTEN (PUSH ENHANCE) (Warm-grey)
This has B INTEN control function and A-sweep enhancing control function.

B INTEN control adjusts the brightness of B-sweep (magnified waveform) when HORIZ DISPLAY is in the ALT or B (DLY'D). Turning the control clockwise increases the brightness in the range from 2 nsec/div to 20 nsec/div of TIME/DIV switch when the control is IN. The lamp on the left lights at this time. When the buttom is OUT position, brightness returns to normal and the lamp goes out.

BEAM FIND
Search the trace or spot positions. If the button is pushed when a trace or spot is outside the screen, it appears on the CRT screen.

FOCUS
Focus traces or spot.

ASTIG
Use this control when traces or spots cannot be focus with the FOCUS control.

SCALE
Adjust the brightness scale. Turning it clockwise brightens the scale, and turning it counterclockwise darkens the scale.

TRACE ROTATION
Adjust traces parallel to the horizontal graticule lines.

CAL 0.6 V
Signal output terminal of a square wave with a calibration voltage of 0.6 V and a repetition frequency of 1 kHz. The output signal is used for adjusting vertical axis deflection factor, probe phase, and sweep rate.

⊥ (Ground terminal for measurement)
Signal ground terminal for measurement. Connect it to the ground terminal of the circuit to be measured.

Vertical Deflection System

↕ POSITION GND REF (PUSH) (CH 1, CH 2)
This control has a position adjusting function and a ground level search (push) function.

As a position adjuster, it adjusts the vertical location of a trace or spot. Turning the control clockwise moves a trace or spot upward, and turning the control counterclockwise moves it downward.

If the control is pushed for ground level search, input signal is not connected to the vertical amplifier, but the input of the vertical amplifier is grounded. The ground voltage, level can be easily measured.

INPUT (CH 1, CH 2)
Connector for connecting a probe or cable to apply input signal to be measured.

The maximum input voltage is 250 V (DC + peak AC) where input signals are directly applied; or 600 V (DC + peak AC) where a probe is used.
(For the maximum input voltage where a probe is used, refer to the instruction manual for probe.)

AC-DC (CH 1, CH 2, CH 3, CH 4)
Switch for selecting a signal input coupling.
AC: The vertical deflection input is AC-coupled. Even if AC input signal is superimposed on DC signal, the DC component is blocked so only the AC component is allowed to pass.
DC: The vertical deflection input is DC-coupled. All the frequency components, including DC, are allowed to pass through.

GND (CH 1, CH 2)
When the GND position is selected, input signal is not connected to the vertical amplifier, but the input circuit of the vertical amplifier is grounded. (Input signal is not

grounded.) Thus, the ground voltage (normally serving as a reference level for measurement) can be easily confirmed.

<For reference>

Difference between GND REF and GND

The GND REF and GND switches are both used for ground level confirmation.

The GND REF switch is pushbutton, which can be pushed with the index finger while the ↕ POSITION control is turned with the thumb and middle finger to shift ground level. If the GND REF button is IN, free-running sweep takes place so that ground level can be checked even if the NORM trigger mode is selected.

The GND switch is a spring-return push button, which may be in the GND position while other switches or controls are being operated. If the AUTO trigger mode is selected in this case, ground reference can be confirmed. If the NORM trigger mode is selected, however, ground reference cannot be checked because sweep stops.

UNCAL (CH 1, CH 2)

If the VARIABLE control is set to other than the CAL position, this lamp lights to indicate non-calibration.

VOLTS/DIV (CH 1. CH 2)

Set the vertical deflection factor to select one of 10 positions from 5 mV/div to 5 V/div to suit input signal level. If the x5 MAG function is used (by pulling the VARIABLE control) at 5 mV/div or 10 mV/div, a high deflection factor of 1 mV/div or 2 mV/div can be obtained.

The VOLTS/DIV switches represent the voltage (of an input signal)per division of the scale on the CRT screen where the VARIABLE control is set to the CAL position.

VARIABLE (PULL x5 MAG) (CH1, CH 2)

The VARIABLE control has the deflection factor adjusting function and waveform magnifying function.

As the deflection factor adjusting it provides continuously variable the uncalibrated deflection factor. The deflection factor is 2.5 times or more when the control is turned fully counterclockwise.

As a waveform magnifying (PULL x5 MAG), it may be pushed to give the same deflection factor as indicated by the VOLTS/DIV switch, or pulled to multiply it by 5.

BANDWIDTH 20 MHz/FULL

Push-push switch for selecting a vertical deflection bandwidth for CH 1, CH 2, CH 3, and CH 4. When the button is OUT position, the bandwidth is an described in the section on Specifications. When the button is IN, a bandwidth of 20 MHz is selected so that the high-frequency noise component of input signals are cut out to make the trace sharp. At this time, the indicator lamp on the left lights.

When observing a signal with a small amplitude, for example, the deflection factor is increased, which increases noise to possibley make it difficult to observe the signal.

CH 2 POLAR INV/NORM

Select the polarity of signal applied to CH 2. NORM when the button is OUT; and INV when the button is IN where the polarity is inverted.

MODE

These MODE button are used for switching vertical deflection operation. The following modes can be selected.

CH 1: Only signal which is applied to CH 1 (x) INPUT is displayed on the CRT screen.

CH 2: Only signal which is applied to CH 2 (Y) INPUT is displayed on the CRT screen.

ALT: The two signals applied to CH 1 and CH 2 INPUT connectors are displayed on the CRT screen. This mode is suitable for observing waveforms where TIME/DIV is set to a position faster than 1 msec/div.

CHOP: The two signals applied to CH 1 and CH 2 INPUT connectors are displayed on the CRT screen. This mode is suitable for observing waveforms where TIME/DIV is set to a position slower than 1 msec/div.

ADD: The ADD mode is selected when both CH 1 and CH 2 buttons are simultaneously pushed in. This mode is used for observing the algebraic sum of the signals applied to CH 1 and CH 2 INPUT connectors or their difference. CH 1 ± CH 2 can be selected with CH 2 POLAR.

QUAD: If the QUAD button is IN when the ALT or CHOP button is IN position, quadruple traces are displayed on the CRT screen. This mode is used for simultaneously displaying the signals applied to CH 1, CH 2, CH 3, and CH 4 INPUT connectors on the CRT screen. Either of the two following quad modes can be selected.

Quad-trace display in the ALT mode: If the ALT and QUAD buttons are pushed in, ALT operation takes place to display 4 signals on the CRT screen.

Quad-trace display in the CHOP mode: If the CHOP and QUAD button are pushed in, CHOP operation takes place to display 4 signals on the CRT screen.

If the HORIZ DISPLAY ALT button is IN during the above operations, the 4 signals are displayed on the CRT screen. If the QUAD button is pushed again to the out (DUAL) position, the SS-5711D operates in the ALT or CHOP mode as indicated on the panel.

CH 3 INPUT (A EXT TRIG IN)

Connect a probe or cable for applying a signal input to be measured or an external trigger signal input for A-sweep. The maximum input voltage is 250 V (DC + peak AC) where the input signal is directly applied; or 600 V (DC + peak AC) where a probe (10 : 1) is used.
(For the maximum input voltage where a probe is used, refer to the instruction manual for probe.)

↕ (CH 3, CH 4)

Select a trace vertical position for CH 3 (CH 4) with this control. Turning it clockwise moves a trace upward, and turning it counterclockwise moves it downward.

1 V - 0.1 V(CH 3, CH 4)

Select CH 3 (CH 4) deflection factor with this control. The value indicated represents a voltage per division of the graticule on the CRT screen.

CH 4 INPUT (B EXT TRIG IN)

Connect a probe or cable for applying a signal input to be measured or an external trigger signal input for B-sweep.

The maximum input voltage is 250 V (DC + peak AC) where the input is directly applied, or 600 V (DC + peak AC) where a probe (10 : 1) is used.
(For the maximum input voltage where a probe is used, refer to the instruction manual for probe.)

Horizontal Deflection Controls

HORIZ DISPLAY

The following modes can be selected with the horizontal deflection control buttons.

A: A sweep mode for normal waveform observation. Sweep time can be selected with the A TIME/DIV switch and A VARIABLE control.
A INTEN: A delayed sweep mode (in which a part of the input signal waveform is magnified for observation)
ALT: Alternate A INTEN sweep and B sweep
B (DLY'D): A sweep delay mode (in which the part selected by delayed sweep is magnified)
X-Y: A mode in which the SS-5711D is used as an X-Y scope, CH 1 serving as X axis and CH 2 as Y axis.

MODE

This button selects either of the following trigger modes.
AUTO: In the AUTO mode, a sweep is started if trigger condition is readied; or a free-running sweep takes place otherwise.
NORM: In the NORM mode, a sweep is started if trigger condition is readied; or no sweep take place otherwise.
SINGLE/RESET: The single trigger mode. This button also has a RESET function so, no trigger signal, it puts the SS-5711D into a ready condition, which is indicated by the lighting of the READY lamp on the right.

READY

This lamp lights when the SS-5711D is in a ready state in the single sweep mode.

↔ POSITION FINE (PULL x10 MAG)

This control has position adjusting and waveform magnifying functions.

It has two kinds of knobs for position adjustment: The large grey knob for coarse horizontal position adjustment, and the small red knob for fine horizontal position adjustment. Turning the knobs clockwise moves the waveform to the right-hand, and turning them counterclockwise moves it to the left-hand.

When the small red knob is pulled, the x10 MAG function is set to magnify the waveform 10 times in the horizontal direction.

COUPLING (A-Sweep)

For selecting an A-sweep trigger coupling (trigger circuit input coupling).
AC: AC coupling is selected. Trigger signal. DC component is blocked. AC signal only is used for triggering.

DC: DC coupling is selected. DC can be used for triggering.
HF REJ: Frequencies over approximately 10 kHz are attenuated by a lowpass filter. Suitable for observing signals cleared of high-frequency noise.
LF REJ: Highpass filter coupling to attenuate low frequencies under approximately 10 kHz.
Suitable for observing signals cleared a low-frequency noise.
FIX: If both the AC and DC buttons are simultaneously pushed in, the trigger level is fixed nearly at the zero point. Thus, it is not necessary to operate the LEVEL control.
TV-H: If both the DC and HF REJ buttons are simultaneously pushed in, TV-H coupling is selected. This trigger coupling is used for ovserving a composite video signal waveform over a period of 1 H by triggering with a television horizontal trigger pulse.
TV-V: If both the HF REJ and LF REJ buttons are simultaneously pushed in, TV-V coupling is selected. This trigger coupling is used for observing a composite video signal waveform over a period of 1 V by triggering with a television vertical trigger pulse.

SOURCE (A-sweep)

Select the SOURCE of A-sweep trigger signal.
CH 1: The input signal applied to CH 1 INPUT is branched out as internal trigger signal.
CH 2: The input signal applied to CH 2 INPUT is branched out as internal trigger signal.
CH 3: The input signal applied to CH 3 INPUT is branched out as internal /external trigger signal.
LINE: The SS-5711D's power line signal is used as trigger signal. This mode is used for observing line signal and line harmonics.
NORM: If both the CH 1 and CH 2 buttons are simultaneously pushed in, the NORM mode is selected, in which the signal for the waveform displayed on the CRT screen in connection with a vertical mode is used as a trigger signal. (For a detailed description of trigger signal selection, refer to the subsequent paragraph on triggering.)

HOLDOFF

This control is used for stabilized synchronization of complex (composite) pulse waveforms. Turning the control fully counterclockwise to NORM minimizes the holdoff period, and turning it clockwise continuously increases the holdoff period.

When the control is turned fully clockwise to B ENDS A, A-sweep ends simultaneously with B-sweep, provided that the HORIZ DISPLAY button A INTEN, ALT or B (DLY'D) is pushed in. This prevents intensity decrease for delayed sweeps with a high magnification ratio.

LEVEL SLOPE (PULL—) (A-Trigger, B-Trigger)

This control has trigger level setting and trigger slope selecting functions.

Push it for positive-going slope trigger level selection; or pull it for negative-going slope trigger level selection.

A TRIG'D

This lamp lights to indicate a triggering state.

A, B TIME/DIV and DELAY TIME

The outer knob is for A TIME/DIV and DELAY TIME, and the inner knob for B TIME/DIV.

The A TIME/DIV AND DELAY TIME control has 23 A-sweep positions from 20 nsec/div to 0.5 sec/div, and selects delays in A INTEN sweep or B (DLY'D) sweep. The value of each position of the control represents a sweep rate and delay time per division on the CRT screen where the A VARIABLE control is turned fully clockwise to the CAL position.

The B TIME/DIV control has 20-sweep positions from 20 nsec/div to 50 msec/div, but no VARIABLE control.

A VARIABLE

Provides continuously the varies A-sweep rate. If the control is turned fully counterclockwise, the value of where the TIME/DIV switch is set at least 2.5 times or more.

A UNCAL

This lamp lights to indicate that A sweep rate is uncalibrating state when A VARIABLE control is out of CAL position.

DELAY TIME MULT

This potentio-meter selects the amount of delay time between the start of A sweep and the start of B sweep.

COUPLING (B-Sweep)

For selecting a B-sweep trigger coupling (trigger circuit coupling).

All functions are the same as those of A-sweep except for LF REJ, TV-H and TV-V.

SOURCE (B -Sweep)

The SOURCE buttons are used for selecting B-sweep trigger signals and a type of delay (continuous delay or triggered delay).

RUNS AFTER DELAY: When the button is IN, RUNS AFTER DELAY is selected for continuous delay.

CH 1: Function is the same as that of A-sweep.

CH 2: Function is the same as that of A-sweep.

CH 4: The input signal applied to CH 4 INPUT is branched out as trigger signal. This function corresponds to the external trigger function of a dual-trace oscilloscope.

(If the CH 1, CH 2, or CH 4 button is pushed in, the triggered delay mode is selected.)

TRACE SEPARATION

This control is used for moving the B-sweep waveform above the A INTEN sweep waveform on the CRT screen when the HORIZ DELAY button ALT is IN. If the contol is turned fully counterclockwise, the A INTEN sweep and B-sweep waveforms overlap, and when the control is turned fully clockwise, the B-sweep wavefrom moves 4 divisions or more.

Counter

See Fig. 2-5.

CHECK

Used for self-check.

A EVENT IN D TIME

Indicates the number of A sweep trigger signals within the delay time (from the A sweep start point to the B sweep start point) with delay sweep.

DELAY TIME

Indicates the delay time (from the A sweep start point to the B sweep start point) with delay sweep.

TIME INT

Used to measure the interval between the START and STOP cursors on the waveform on the CRT.

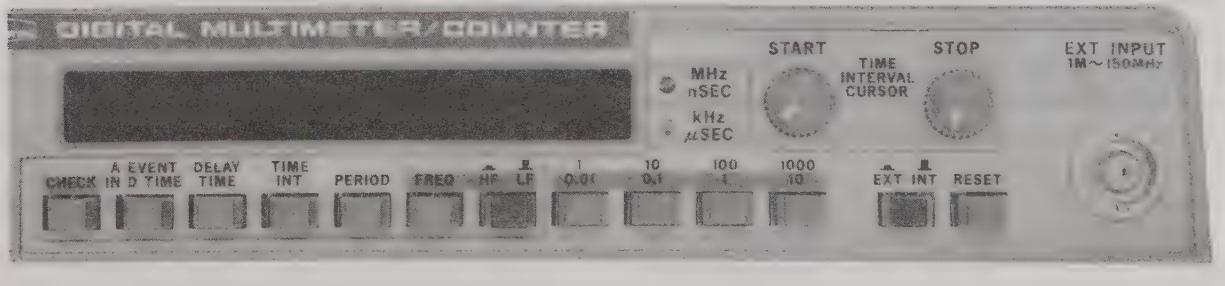
PERIOD

Set when period is measured. The measurement range is 0.5 μsec to 10 sec in the LF mode, and 10 nsec to 1 μsec in the HF mode.

FREQ

Set when frequency is measured. The measurement range is 0.1 Hz to 10 MHz in the LF mode, and 1 MHz to 100 MHz (150 MHz with EXT INT) in the HF mode.

Figure 2-5. Counter



HF-LF

Used to select measurement range when measuring frequency or period.

RANGE (0.01, 0.1, 1, 10/1, 10, 100, 1000)

These switches are used to select the position of the decimal point when the frequency or period of an input signal is measured. The upper display indicates period, the lower display, gate time (sec).

EXT-INT

This switch is used to select an internal signal source (signal supplied from the oscilliscope) or external signal source (signal supplied via the EXT INPUT terminal) when measuring frequency or period.

RESET

This switch initializes the counter (ie., sets it to zero) so that it is ready for new input.

EXT INPUT 1M ~ 150 MHz

The external signal is input via this terminal when frequency or period is measured.

TIME INT EVENT CURSOR

These controls are used to set the position of the waveform cursor on the CRT when time interval is measured.
START: Used to set cursor start point.
STOP: Used to set cursor stop point.

MHz • nSEC – kHz, μSEC

Used to set the unit in which measurement is displayed. The relevant of the two LEDs is lit to indicate which has been selected.

DISPLAY

Storage display using red LEDs. Non-storage display is possible only for A EVENT IN D TIME.

Digital multimeter

See Fig. 2-6.

LO-HI

Signal input terminals for use when measuring DC • AC voltage resistance and DC • AC current. Plug the black lead into the LO terminal, and the red, into the HI terminal.

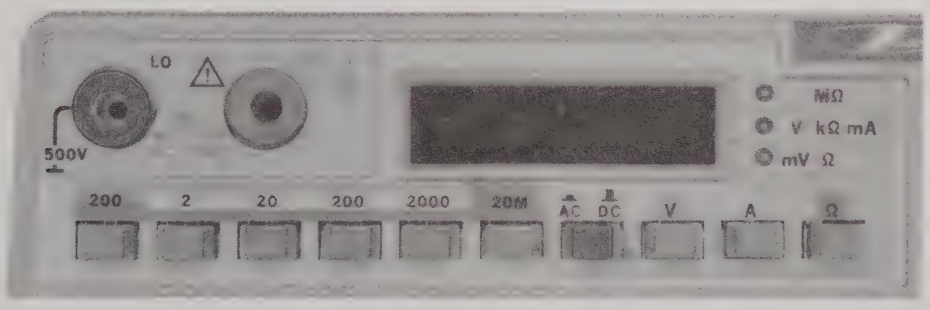
200, 2, 20, 200, 2000, 20M

These switches are used to select the position of the decimal point when voltage, resistance, or current are measured.

AC-DC

This switch is used to select measurement of either AC or DC voltage or current.

Figure 2-6. Digital Multimeter



V

Used when measuring DC or AC voltage.

A

Used when measuring DC or AC current.

Ω

Used when measuring resistance.

MΩ-V, kΩ, mA-mV, Ω

Used to set the unit in which measurement is displayed. The relevant of the three LEDs is lit to indicate which has been selected.

DISPLAY

Static display using red LEDs.

2-3-2 Rear Panel

CH 1 OUT

The input signal of CH 1 is provided. The output signal is used as an input signal source for a frequency counter or others. The output voltage is 40 mV ± 20% per division of the graticule on the CRT screen in case of 50-ohm termination.

A GATE OUT

Provides the positive output voltage of approximately 5 V synchronized with A-sweep during its period.

B GATE OUT

Provides the positive output voltage of approximately 5 V synchronized with B-sweep during its period.

Z AXIS INPUT

Apply a signal for external intensity modulation to this input terminal. The maximum input voltage is 50 V (DC + peak AC).

CAL 10 mA

A square wave current of 1 kHz, 10 mA flows through the current loop terminal in the arrow direction (from right to left). Use its current output for checking and calibrating the current probe.

⏚ (Ground terminal for protection)

Ground terminal for protecting the oscilloscope. When supplying a line voltage from a 2-core electrical outlet, be sure to connect this terminal to the ground for preventing danger.

AC LINE INPUT

AC voltage is supplied to this connector. Connect the supplied power cord to it.

A.B.C.D (Voltage Selector plug)

Set the voltage selector plug's arrow mark to one of the A, B, C or D position to suit the AC line voltage. Refer to the table of line voltage ranges.

FUSE

Fuse holder

2-3-3 Bottom Cover

GAIN

This is for adjusting vertical deflection factor.

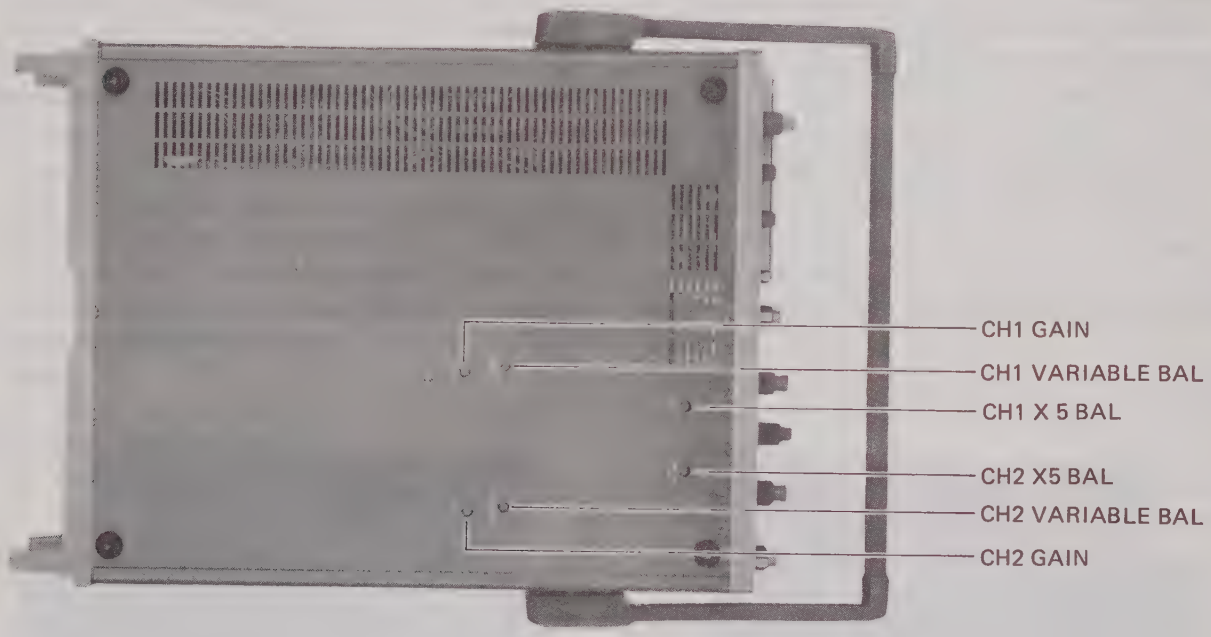
x5 BAL

This is for adjusting vertial deflection position when the PULL x5 MAG is pushed or pulled.

VARIABLE BAL

This is for adjusting the movement of vertical trace position when the vertical deflection VARIABLE control is turned.

Figure 2-7. Bottom cover



2-4 OPERATING INSTRUCTIONS

The basic operating instructions for the SS-5711D used for observing voltage waveforms are explained below.

2-4-1 Basic Operation for Signal Observation

The follwoing procedure applies where a CAL 0.6 V signal is applied to CH 1 INPUT with the supplied probe for observation.

Turning POWER On

Before connecting the power cord, check the AC line voltage with a voltmeter, and set the voltage selector plug to the proper position to suit the line voltage.

1. Set the POWER to OFF position, and connect the power cord to the AC LINE INPUT connector on the rear panel and an electrical outlet.
2. Set the controls as follows. See Figure 2-8 and 2-9.

A INTEN	Midrange
MODE (Vertical)	CH 1
AC-DC (CH 1)	AC
↕ POSITION (CH 1)	Midrange
HORIZ DISPLAY	A
MODE (Horizontal)	AUTO
←→ POSITION	Midrange
FINE (PULL x10 MAG)	Midrange (button IN)

3. Push the POWER button up to the ON position. A trace is displayed in about 15 seconds. Adjust its intensity as appropriately with the INTEN control.

Focusing

4. Set the A TIME/DIV switch to the 1 msec/div position, and adjust the FOCUS control to make the trace clear and sharp.

Figure 2-8. Power, CRT and Calibration controls

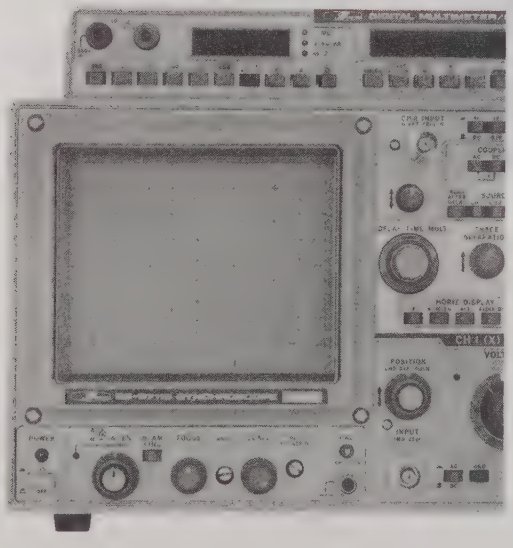
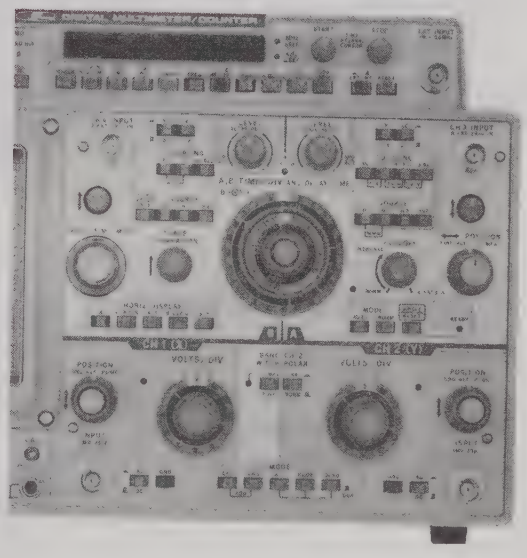


Figure 2-9. Vertical Deflection and Horizontal Deflection Controls



Applying signals and triggering

5. Set the controls as follows.
   COUPLING (A-Sweep) AC
   SOURCE (A-Sweep) CH 1
   VOLTS/DIV (CH 1) 10 mV
   VARIABLE (CH 1) CAL
6. Using the supplied probe, connect CH 1 INPUT to the CAL. 0.6 V terminal.
7. Turn the LEVEL (A-Sweep) control to nearly the mid-range, and a 6-division calibration voltage waveform is displayed on the CRT screen. It is triggered by internal trigger (AC coupling) in the AUTO mode.
   For a detailed description of triggering, refer to Triggering in a subsequent paragraph.

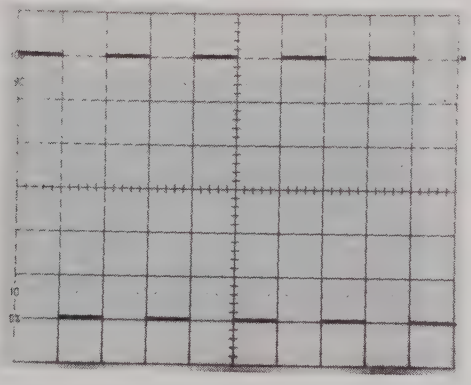
Deflection Factor Setting

8. As VOLTS/DIV switch is turned form 20 mV, 50 mV, and on to 5 V, the deflection factor decreases so that the waveform amplitude on the CRT screen becomes small. The amplitude also decreases when the VARIABLE control is turned counterclockwise.
   Adjust the input deflection factor with the VOLTS/DIV switch and VARIABLE control so that the input signal has an amplitude easy to be observed on the CRT screen.

Sweep Rate Setting (A-Sweep)

9. As the A TIME/DIV switch is turned from 0.5 msec, 0.2 msec and on the 20 nsec, the displayed waveform that can be observed decreases. There are kinds of signals to be measured. To observe various signals on a suitable cycle, set an appropriate sweep rate with the A TIME/DIV switch and A VARIABLE control. For the sweep rate setting procedure, refer to the subsequent paragraph on sweep rate setting.
   The basic operation procedures for observing signal waveforms have been described above.

Figure 2-10. Calibrator waveform



2-4-2 Applying Signal

Apply the signals to be observed to CH 1, CH 2, CH 3, and/or CH 4 INPUT connectors.

Generally a passive probe is used for applying a signal to the oscilloscope.

The use of a probe prevents the waveforms on the CRT screen from being adversely affected by the induction of an external electric field. If a 10 : 1 probe is used, the input impedance is higher than where a 1:1 probe is used, and thus the load effect on the signal source is lessened. This permits accurate waveform observation in spite of a high signal source impedance.

The 10:1 probe, however, attenuates the input signal to 1/10 so the VOLTS/DIV readings of input signal amplitude must be multiplied by 10.

The 1:1 probe is suitable for observing low-frequency low-level signals because a large load effect is produced on high-frequency signals.

(For a detailed description of the probe, refer to Section 3 MEASURING PROCEDURES and the instruction manual for probe.)

2-4-3 Signal Input Coupling Selection

Kinds of signals, including DC, AC, and AC superimposed on DC, may be applied for observation. For accurate observation of these kinds of signals, select the proper signal input coupling with the AC-DC switch.
(See Figure 2-11. and 2-12.)
AC Coupling:
In AC coupling, a DC signal is blocked by a capacior so that only the AC signal passes it. Thus, the AC signal

waveform will be out of the screen by the DC voltage so it can be observed with its amplitude increased on the screen. If a signal with a low repetition frequency is observed in the AC coupling mode, a sag appears in the waveform if the signal is a square wave; or if it is a sine wave, the amplitude on the screen is attenuated about –3 dB per 4 Hz from the actual one.

DC Coupling:

DC coupling is selected for observing all the frequency components of a signal input.

Ground Coupling:

The input of the vertical amplifier circuit is grounded so a ground level trace is displayed on the screen. The ground level normally serves as reference level in measurements.

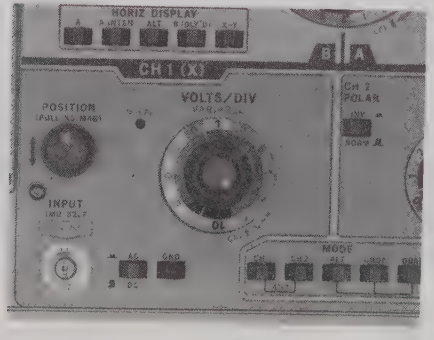
2-4-4 Vertical Deflection Factor Setting

To observe a signal waveform, it must be displayed with an appropriate amplitude on the CRT screen.

The CH 1 and CH 2 VOLTS/DIV switches are deflection factor select switches, and their VARIABLE controls are for fine adjustment of deflection factor. (See Figure 2-11.)

If the VARIABLE controls are turned fully clockwise to the CAL position, the positions of the VOLTS/DIV switches directly indicate the selected deflection factors, which represent the voltage per division of the screen scale for the signal waveforms displayed.

Figure 2-11. CH 1 VOLTS/DIV switches and VARIABLE control and AC-DC, GND switches



The deflection factor select switches for CH 3 and CH 4 have two position, 0.1 V/div and 1 V/div, but no VARIABLE controls. (See Figure 2-12.)

2-4-5 Triggering

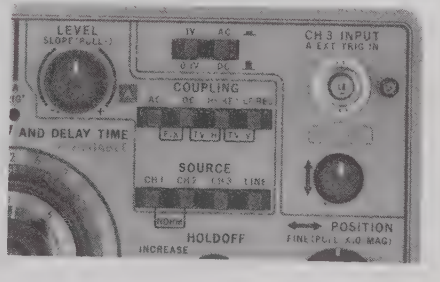
It is necessary to have a correct understanding of the triggering procedure in using an oscilloscope.

The triggering procedure for A-sweep (where the HORIZ DISPLAY button A is IN) is described below. The triggering procedure for B-sweep that is necessary in delayed sweep operation is described in the subsequent paragraph on Waveform Magnification Operation.

The following must be set for A-sweep triggering.

- Trigger Signal
  Selects CH 1, CH 2, CH 3, NORM, or LINE with the SOURCE button.
- Trigger Coupling
  Selects AC, DC, HF REJ, LF REJ, FIX, TV-H, or TV-V with the COUPLING button.
- Trigger system
  Selects AUTO, NORM, or SINGLE-RESET with the MODE switch.
- Slope
  Selects either positive-going (+) or negative-going (–).
- Level
  Selects a suitable trigger level.

Figure 2-12. CH 3 0.1 V and AC-DC switches



• Hold off

Selects a suitable HOLD OFF time.

A detailed description of the above 6 items is given below.

Trigger Signal

To observe an input signal waveform, it is necessary to apply an input signal, or a signal which has a constant time relationship with the input signal (called a trigger signal), to the trigger circuit to drive it.

Select internal trigger (CH 1, CH 2, CH 3, NORM), external trigger (CH 3), or line trigger (LINE) with the SOURCE button.

Input signal applied to input connector is brached off from vertical deflection system and method that applies it to the trigger circuit is called internal trigger.

The input signal is also used as internal trigger circuit. Thus, operation is simple.

The method of applying an external input signal, or a signal which has a constant time relationship with the input signal, to the trigger circuit is called external trigger. External trigger has the follwing advantages.

- External trigger is unaffected by the channel to which an input signal is applied. In the internal trigger mode, the trigger signal amplitude changes whenever the deflection factor is changed, and thus the trigger level must be adjusted accodingly. In the external trigger mode, once trigger condition is established, the signals remain synchronized even if the signal to be measured changes in amplitude.
- If desired a specific time before, or after, an input signal waveform, apply this signal as trigger to EXT TRIG IN (CH 3) so that the desired waveform can be observed.

The mothod of applying a line waveform from the built-in power transformer to the trigger circuit is called line trigger, which is used for observing line waveforms and line high frequencies.

Internal Trigger (CH 1, CH 2, CH 3, NORM)

If SOURCE CH 1 is selected, the input signal that is applied to CH 1 is used as trigger signal.

If SOURCE CH 2 or CH 3 is selected, the input signal that is applied to CH 2 or CH 3 is used as trigger signal.

If SOURCE NORM (CH 1 and CH 2 pushed in simultaneously) is selected, the input signal applied to CH 1 is used as trigger signal in the CH 1 vertical mode, or the input signal applied to CH 2 is used as trigger signal in the CH 2 vertical mode. In the ALT vertical mode, the input signal applied to CH 1 triggers CH 1, and that applied to CH 2 triggers CH 2. Alternate use of trigger signals to suit the display on the screen is convenient for comparison of waveforms. In the CHOP or ADD mode, use CH 1, CH 2, or CH 3 instead of NORM because trigger is generally unstable.

External Trigger (CH 3)

If SOURCE CH 3 is selected, the input signal that is applied to CH 3 INPUT (A EXT TRIG IN) is used as external trigger signal.

Line Trigger (LINE)

If SOURCE LINE is selected, line trigger is available.

Trigger Coupling

The COUPLING button is used for selecting a coupling for the trigger circuit input. AC, DC, HF REJ, LF REJ, FIX, TV-H, or TV-V can be selected. Select one of them steady triggering according to the kind of trigger signal(AC, DC, composite video signal, etc.).

AC: The trigger circuit input is AC-coupled so the DC component of the trigger signal is blocked. Thus, only the AC component of the trigger signal is used for triggering. Generally, AC coupling is convenient, but triggering is difficult if the trigger frequency is below 10 Hz.

DC: The trigger circuit input is DC-coupled for DC triggering. If a AC trigger signal is superimposed on DC, whose voltage is outside the trigger level range, trigger is ineffective.

HF REJ: The trigger circuit input comprises a lowpass filter which rejects high-frequency trigger signals (over about 10kHz) and high-frequency noises mixed with high-frequency signals and passes only low-frequency components.

LF REJ: The trigger circuit input comprises a high pass filter which rejects low-frequency trigger signals (over about 10 kHz) and low-frequency noises mixed with the trigger signals, and passes only high-frequency components.

FIX: The trigger circuit input is AC-coupled and the trigger level is fixed nearly at 0 V, so trigger takes place without operating the LEVEL control.

TV-H: Uses a television horizontal synchronization pulse for triggering in observing signals over a period of 1H.

TV-V: Uses a television vertical synchronization pulse for triggering in observing composite video signals over a period of 1 V.

Trigger System

The SS-5711D offers selection of the trigger mode of AUTO, NORM, or SINGLE/RESET.

AUTO: Auto trigger is selected. If a trigger signal with the proper frequency and level is applied to the trigger circuit, trigger condition can be readed by turning the LEVEL control to an appropriate trigger level. In the following cases, however, free-running sweeps occur due to the absence of trigger condition.

1. No trigger signal.
2. A tigger signal too small.
3. The LEVEL control set out of the trigger signal used.
4. A trigger signal with a frequency below 50 Hz.

NORM: Normal trigger is selected. If a trigger signal with the proper frequency level is applied to the trigger circuit, trigger condition can be readied by turning the LEVEL control to an appropriate trigger level.

In the following cases, however, sweeps stop and the instrument gets into a ready condition due to the absence of trigger condition.

1. No trigger signal.
2. A trigger signal too small for the LEVEL control to match its level.
3. The LEVEL control set out of the trigger signal used.

SINGLE-RESET: Single sweep mode. For details, refer to the subsequent description of the single sweep mode.

SLOPE

Push the LEVEL control for triggering from a positive-going slope, or pull it for triggering from negative-going slope.

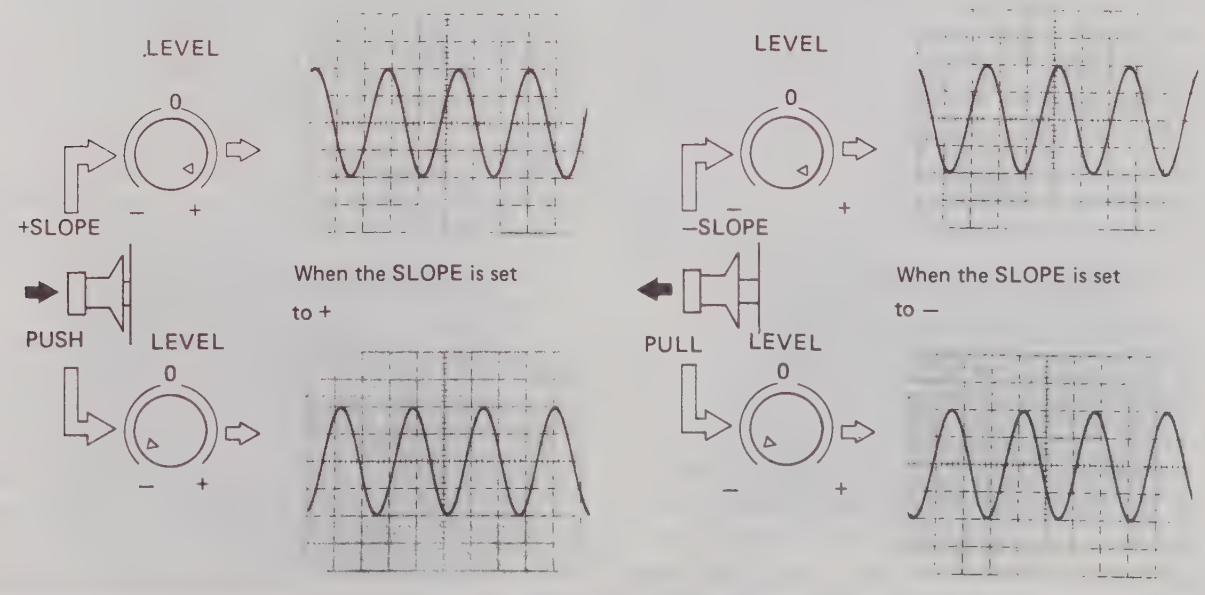
LEVEL

If the LEVEL control is neary at the midrange trigger level is set place at neary 0 V.

The trigger level moves in the positive (+) direction as the LEVEL control is turned clockwise, or in the negative (–) direction as the control is turned counterclockwise. (See Figure 2-13.)

In the coupling mode FIX, the trigger level is fixed nearly at 0 V. Thus, it is not neccessary to operate the LEVEL control for triggering.

Figure 2-13. SLOPE versus LEVEL



HOLDOFF

Complex waveforms of a pulse train may appear overlapped despite synchronization depending on sweep rate setting.

If that occurs, turn the HOLDOFF control from the NORM position (fully counterclockwise) toward INCREASE to change the holdoff time. If the HOLDOFF control is adjusted to start a sweep at the basic input signal cycle, the wave-forms are displayed in a way easy to observed.

2-4-6 Sweep Rate Setting

Many kinds of signals, some with a low repetition frequency and some with a high one, and some pulses with a fast rise and some with a low rise, may be measured. To measure these kinds of signals, it is necessary to select a suitable sweep rate.

When measuring signals with a low repetition frequency or slow rise pulses, for example, select a low sweep rate; and when measuring signal with a high repetition frequency or fast rise pulses, select a high sweep rate.

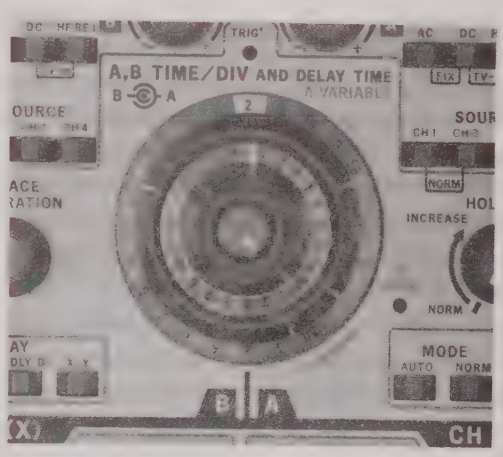
If the HORIZ DISPLAY mode A is selected, A-sweep (normal sweep) takes place. In this case, operate the A-sweep controls.

The sweep rate control used in the A-sweep mode is A TIME/DIV, and its VARIABLE control is for sweep rate fine adjustment. (see Figure 2-14)

If the A VARIABLE control is turned fully clockwise to the CAL position, each position of the A TIME/DIV switch directly represents the sweep rate it indicates. If the A VARIABLE control is turned fully counterclockwise, the sweep rate pointed by the A TIME/DIV switch is 2.5 times the indicated value or less.

The sweep rate control used in the B-sweep mode is B TIME/DIV switch, which has no VARIABLE control.

Figure 2-14. TIME/DIV and VARIABLE controls



2-5 APPLIED OPERATION OF OSCILLOSCOPE

The Oscilloscope SS-5711D has various convenient functions for signal observation. The following operating instructions for observing signals by use of its various functions are based on the assumption that you have sufficiently understood the basic operation procedures.

2-5-1 Operation for Dual-trace Observation

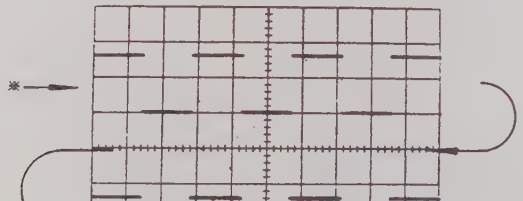
As described in the section on basic operations, the SS-5711D used as a dual-trace oscilloscope can display two signals to be measured on the CRT screen. Either ALT (alternate sweep) or CHOP (chopped sweep) can be selected for dual-trace observation. By using the ALT or CHOP mode as appropriate, dual-trace observation can be made at rates ranging from low to high speed.

Dual-Trace observation in the ALT mode

The ALT mode is suitable for observing two signals that have a high frequency. In this mode, a sweep occurs alternately between CH 1 and CH 2 so dual traces can be observed by applying two signals to CH 1 and CH 2 INPUT connectors.

The alternate sweep mode covers the full TIME/DIV range so a slow sweep rate makes dual-trace observation difficult.

Figure 2-15. Dual-trace observation in the ALT mode



Select the CHOP mode mentioned below when observing low-frequency signals.

Dual-Trace observation in the CHOP mode

The CHOP mode is suitable for dual-trace observation of low-frequency signals. CH 1 and CH 2 sweep are switched from one to the other about every 500 kHz so that, contrary to the ALT mode, it is difficult to observe high-frequency signals because their traces turn into dotted lines. Use the ALT mode for high-frequency signals.

2-5-2 Operation for Observation of the Sum of Two Signals or Their Difference

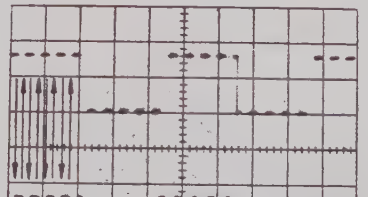
Observation in the ADD Mode

The ADD mode is selected if the vertical MODE buttons CH 1 and CH 2 are simultaneously pushed in. If signals are applied then to CH 1 and CH 2 INPUT connectors, the sum of the two signals (CH 1 + CH 2) can be observed. If the CH 2 POLAR button is pushed in to the INV position then, the difference between the two signals [(CH 1) + (−CH 2)] can be observed.

The deflection factor can be independently adjusted for CH 1 and CH 2 in the ADD mode so select a range to suit the purpose.

In the ADD mode, the ↕ POSITION controls for CH 1 and CH 2 may be used for adjusting trace positions, but for accurate measurement, the two POSITION controls should be kept nearly at the center.

Figure 2-16. Dual-trace observation in the CHOP mode



2-5-3 Operation for Quadruple-Trace Observation

The SS-5711D can simultaneously display up to four signals on the CRT screen aside form the dual-trace capability.

If the vertical MODE buttons ALT and QUAD, or CHOP and QUAD are simultaneously pushed in, traces for CH 1, CH 2, CH 3, and CH 4 are displayed on the CRT screen. Thus, by applying the four signals to be measured to the respective input connectors, the four signals can be simultaneously observed.

If the HORIZ DISPLAY mode ALT is selected under this condition, 8 traces are displayed on the screen as shown in Figure 2-18, giving A INTEN and B sweeps for the respective channels.

The vertical axis of quadruple traces is displayed by chopped operation if the vertical MODE buttons CHOP and QUAD are pushed in, or by alternate operation if the vertical MODE buttons ALT and QUAD are pushed in. When observing signal faster than 1 msec/div, push the vertical MODE buttons CHOP and QUAD IN. When observing signal slower than 1 msec/div, push the vertical MODE buttons ALT and QUAD IN.

2-5-4 Operation for Enlarging Waveform on the CRT Screen

Waveforms on the CRT screen can be partially magnified timewise (in the horizontal axis direction) for detailed observation by any of the following three methods.

- To use a fast sweep rate
- To use the x10 MAG function to magnify.
- To use the delayed sweep function to magnify.

These are explained in detailed below.

Using a fast sweep rate

Use a fast sweep rate to magnify the leading end of the waveform on the screen timewise. If the center part or tailing end of the waveform is magnified by using a fast sweep rated, those parts will go out of the CRT screen. In such a case, use the x10 MAG function to magnify the waveform.

Magnifying waveforms by x10 MAG

This method is mainly used to magnify the center part or tailing end of waveforms timewise.

Move the desired part to the center of the CRT screen with the horizontal POSITION control, and pull the FINE (PULL x10 MAG) knob so the desired part is magnified 10 times in the horizontal direction. The trace length at this time is approximately 10 divisions on the CRT screen, but is actually increased to approximately 100 divisions, and can be observed from end to end with the horizontal POSITION and FINE controls.

This method is simple, but magnification is limited to 10 times. The sweep rate to be used for extended observation is the value indicated by the TIME/DIV switch multiplied by 1/10.

Thus, the fastest sweep rate can be extended to 5 nsec/div.

Figure 2-17. Quadruple-trace observation

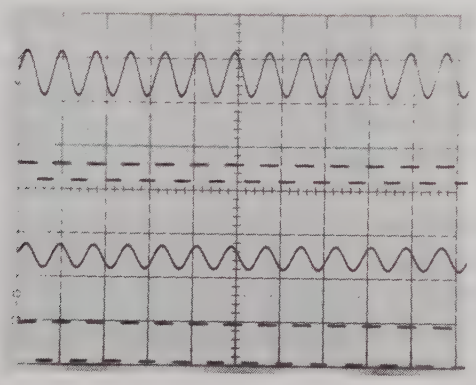
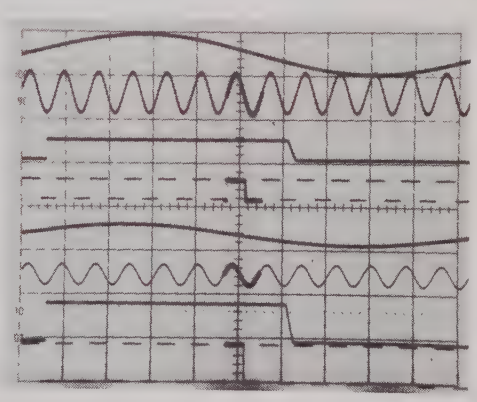


Figure 2-18. Quadruple-trace observation in the ALT mode



Extending waveform by delayed sweep

The method of magnifying waveform in above paragraph is simple. It can increases the displayed sweep speed by 10 times, but it is limited to 10 times.

The method of magnifying waveform by delayed sweep can magnify every part of the waveform displayed magnifier ratio between A sweep and B sweep is determined by

$$\frac{\text{A TIME/DIV (sec/div)}}{\text{A TIME/DIV (sec/div)}}$$

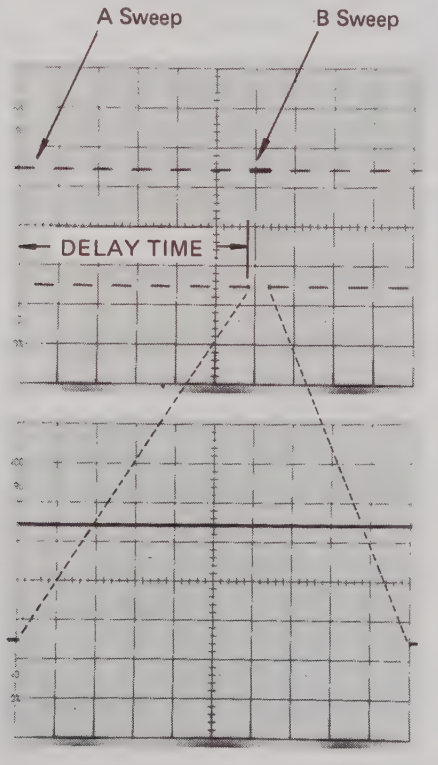
but this method is limited frequency of input signal. If an input signal has a high frequency and if the A TIME/DIV switch is at the fastest speed before magnification, the waveform cannot be magnified any more.

Therefore, delayed sweep magnified is suitable for enlarging the desired part of an input signal that has a relatively low frequency.

Delayed sweep magnification comes in continuous delay and trigger delay as described below.

Continuous Delay: Operation for continuous delay is as follows:

Figure 2-19. Magnification by Continuous Delay



1. Select the HORIZ DISPLAY mode A , apply an input signal, and triggering.
2. Turn the B TIME/DIV switch to a position faster than the A TIME/DIV switch.
3. Select the B-sweep SOURCE mode RUNS AFTER DELAY.
4. Select the HORIZ DISPLAY mode A INTEN

If the DELAY TIME MULT dial is turned clockwise after taking the above steps, a particularly intensity maduration part appears as shown in the upper waveform of Figure 2-17, and moves continuously from left to right. If this intensity moduration part is moved to a position where is measured, and if the HORIZ DISPLAY mode B (DLY'D) is selected, that part can be magnified fully on the CRT screen as shown in the lower waveform of Figure 2-19.

Use the B TIME/DIV switch for selecting a B (DLY'D) sweep rate. The magnification ratio increases as the sweep rate is increased. If the magnification ratio is raised so much delay jitter showns, making waveform observation difficult. Thus, there are limitations on magnified waveform observation by countinuous delay due to delay jitter. In such a case, use the trigger delay described below if a higher magnification ratio is desired.

The delay time of the magnified part can be calculated by multiplying the indicatd value of A TIME/DIV switch by the indicated value of the DALAY TIME MULT dial.

Trigger Delay: Trigger delay can be selected if the B-sweep SOURCE switch is set to CH 1, CH 2 or CH 4 (if a trigger signal is applied to CH 4). Delayed magnification can be made by B-sweep triggering and performing the same steps of operation as those of continuous delay.

The magnified part (B-sweep) in trigger delay starts at a trigger point subsequent to the delay time selected with the DELAY TIME MULT dial. The tirgger point moves as DELAY TIME MULT is turned.

If DELAY TIME MULT is turned during a B (DLY'D) sweep, the waveform may appear still, but actually you are watching the part selected in the A INTEN sweep mode.

B-Sweep Trigger

The B-sweep trigger controls include B-sweep COUPLING SOURCE, and LEVEL.

The LEVEL and COUPLING (except for LF REJ, TV-H, TV-V) fuctions and operations are the same as the A-sweep LEVEL and COUPLING functions and operations. The

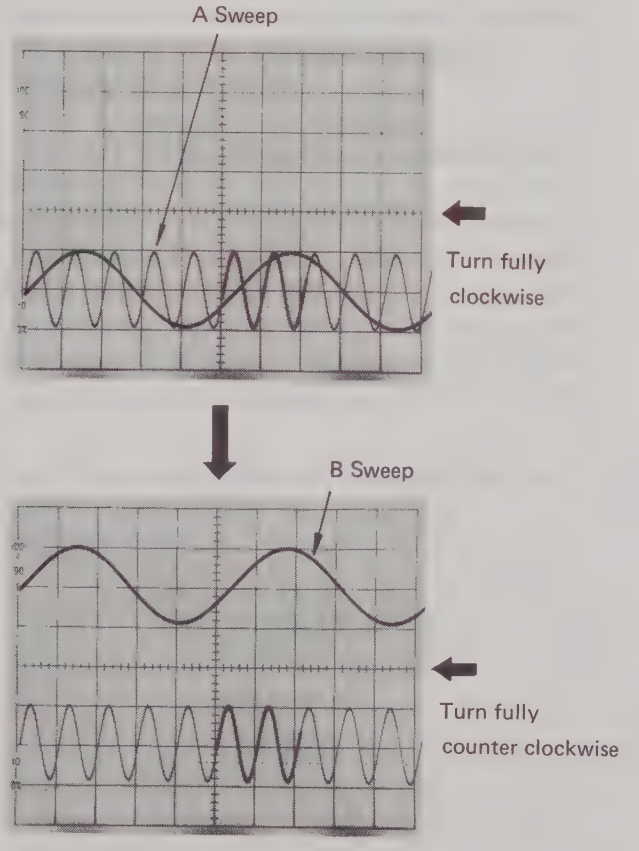
SOURCE button is used for selecting a trigger signal. RUNS AFTER DELAY is for continuous delay; and CH 1, CH 2 and CH 4 (external trigger function of the conventional oscilloscope) are for trigger delay. If CH 4 is selected, apply a trigger signal to CH 4 INPUT. If CH 1, CH 2 is selected, the same function as in the A-sweep mode is performed.

2-5-5 Operation for ALT Sweep

In the ALT sweep mode, an A INTEN sweep and a delayed B-sweep occur alternately. Thus, a non-magnified part and a magnified part can be simultaneously observed. The operation procedure is as follows:

1. Select the HORIZ DISPLAY mode A, apply an input signal, and synchronize.

Figure 2-20. TRACE SEPARATION Adjustment



2. Set B TIME/DIV switch to a position faster than that of A TIME/DIV switch.
3. Set the B-sweep SOURCE switch to RUNS AFTER DELAY.
4. Set the HORIZ DISPLAY switch to ALT.
5. Move the B-sweep waveform to the position where the A-sweep waveform is measured, using the DELAY TIME MULT dial.
6. Turn the B TIME/DIV switch, and magnify.
7. Move the B-sweep waveform (magnified waveform) to a point where it is easy to observe as shown in Figure 2-20, using TRACE SEPERATION.

Note: If TRACE SEPERATION is turned fully counter-clockwise, the A-sweep waveform and B-sweep (magnified) waveform are completely double. When it is turned fully clockwise, the B-waveform moves about 4 divisions or more above the A-sweep waveform.

The delay time of the magnified part can be easily obtained in the same sweep by the formula shown in the above paragraph on waveform magnification by delay. If the magnification ratio is increased, jitter shows on the CRT screen. In that case, set the SOURCE button to other than RUNS AFTER DELAY for trigger delay as in B (DLY'D) sweep.

2-5-6 Operation for Observing Television Composite Video Signal Waveforms

The SS-5711D has a television synchoronizing separator circuit so that television and other composite video signal waveforms can be displayed. The operation procedure is as follows.

Observation by Normal Sweep

1. Set the controls as follows:

HORIZ DISPLAY	A
Vertical MODE	CH 1 or CH 2 (whichever a signal is applied to)
COUPLING	TV-V (when observing a V signal), or TV-H (when observing an H signal)
SOURCE (internal trigger)	CH 1 or CH 2 (whichever a signal is applied to) or NORM

(external trigger) CH 3 (Apply a signal to CH 3 INPUT.)

2. Apply the composite signal to be measured to CH 1, CH 2, or CH 3.
3. Adjust so that the composite video signal waveform has an amplitude of 1 division or more (30% of the trigger signal component) on the screen.
4. Selects the horizontal mode AUTO or NORM.
5. Turns the SLOPE control to the + position if the trigger signal component of the composite video signal measured is positive-going; or to the -position if it is negative-going. (Refer to Figure 2-21, and 2-22.)

Figure 2-21. Where H Trigger Signal is Positive

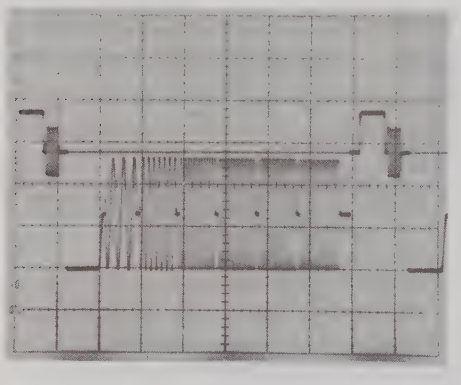
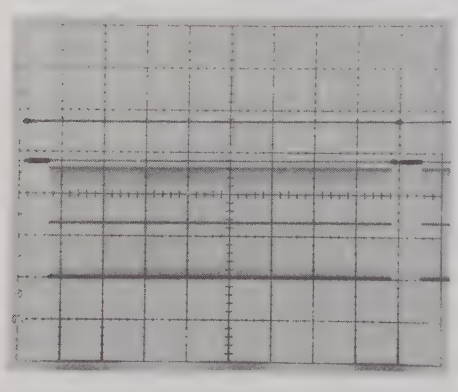


Figure 2-22. Where V Trigger Signal is Positive



6. Turn the TIME/DIV switch to display the desired part of the signal on the screen.

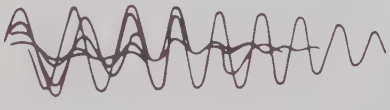
Magnified Observation by Delayed Sweep

1. In continuation of the above steps, set the HORIZ DISPALY switch to A INTEN.
2. Turn A TIME/DIV switch to 2 msec/div.
3. When observing by continuous delay, set the B-sweep SOURCE button to RUNS AFTER DELAY; or when trigger delay is desired, set it to CH 1 or CH 2 or CH 4. (Apply the trigger signal to CH 4 INPUT if CH 4 is selected.)
4. Select the desired part to be magnified, using DELAY TIME MULT.
5. Set the HORIZ DISPLAY switch to B (DLY'D), and select the desired magnification ratio with B TIME/DIV switch.
6. The SS-5711D has no 1st-2nd field switching function, but it can be accomplished with an accuracy of about 50% by shifting the AC-DC button or by pushing or pulling the SLOPE control.

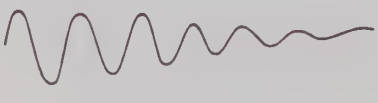
2-5-7 Operation for Single Sweep

In observing discharge waveforms or fast-speed transient phenomena, such as the chatterings of an operating relay, the waveforms are displayed one upon another. If waveform is displayed at a slower sweep rate, transient phenomena can not be observed in detail. If the single sweep function is used for observing such phenomena, the transient

Figure 2-23. Example of Repeated Sweep and Single Sweep Wave forms



Repeated Sweep



Single Sweep

phenomena can be observed without being double and photographed. (See Figure 2-23.)

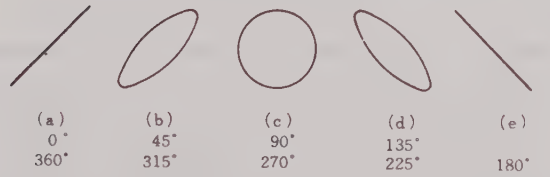
The basic operation procedure for single sweep using a calibrator voltage is described below.

1. Select the HORIZ DISPLAY mode A and the horizontal mode NORM.
2. Using one of the supplied probes, apply a CAL 0.6 V to INPUT, set VOLTS/DIV to 10 mV and synchronize.
3. Select the horizontal mode SINGLE, and push the SINGLE/RESET button, and confirm that only a single sweep takes place.
4. Disconnect the input signal, and push the SINGLE/RESET button. Confirm that the READY lamp on the right lights.

If the READY lamp lights after these steps, the oscilloscope is in a sweep standby state, ready to make a single sweep if a trigger signal is applied. (The oscilloscope may not be in a standby state if the LEVEL control is at some point near the center. If so, turn the LEVEL control slightly counterclockwise or clockwise.) If a transient signal is applied to the oscilloscope, it sweeps only once, display the correct waveform.

The single sweep function is effective also in the A INTEN and B (DLY'D) sweep modes. If an external trigger signal is applied and the same operations as in the internal trigger mode are taken, a single sweep is also available. A dual-trace simultaneous single sweep can be mode in the CHOP mode, but not in the ALT mode.

Figure 2-24. Lossajou's Figure of Sine Wave



2-5-8 Operation for Use as X-Y Scope

By performing operations for use as an X-Y scope, phase differences, Lissajours' figures of various frequency ratios, and hysteresis curves can be observed.

The SS-5711D operates as an X-Y scope, and aspot appear nearly at the center of the screen when the HORIZ DISPLAY mode X-Y is selected.

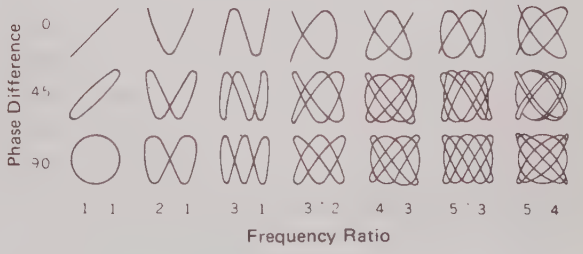
If signals are applied to CH 1 and CH 2 INPUTs, the signal applied to CH 1 drives the horizontal axis (X) and the signal applied to CH 2 drives the vertical (Y) axis, thus describing a Lissajou's figure.

The X-axis deflection factor is adjusted with the CH 1 VOLTS/DIV switch and its VARIABLE control; and the Y-axis deflection factor with the CH 2 VOLTS/DIV switch control and its VARIABLE contol. If the VARIABLE controls are set to the CAL position, the deflection factors are as indicated by the VOLTS/DIV switches,. Vertical position can be adjusted with the CH 2 ↕ POSITION control, and horizontal position with the ←→ POSITION control and its FINE control.

Figure 2-24 and a-25 show Lissajou's figures of measuring sine waves and different frequencies. As shown in these figures, varied waveforms are displayed depending on phase difference and frequency ratio. These waveforms are observed still.

Figure 2-26 shows examples of Lissajou's figure of different waveforms.

Figure 2-25. Lissajou's Figures of Various Frequency Ratios



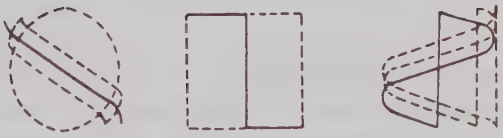
2-5-9 Z Axis System

In addition to the vertical (Y) axis and horizontal (X) axis, there is also a Z axis (which modulates intensity but does not affect the waveform displayed) for displaying electrical phenomena. The SS-5711D has Z AXIS INPUT on the rear panel which is fed to the CRT circuit to modulate the intensity of waveform displayed on the CRT screen.

If an input voltage of 0.5 Vp-p or more is applied, the intensity is modulated. A negative input signal increases the intensity, and a positive input signal decreases it. The frequency range is from DC to 5 MHz, and the maximum input it voltage is 50 V (DC + peak AC.)

A time reference for the waveform displayed can be obtained by applying a time marker to Z AXIS INPUT. Sweep rate can be calibrated by use of the time marker, even if observing input signal at uncalibrated sweep rate.

Figure 2-26. Lissajou's Figure of Different Waveforms (Frequency ratio 1 : 1)



(a) Sine wave and triangle wave (b) Sine wave and square wave (c) Sine wave and sawtooth wave

2-6 OPERATION OF COUNTER

This section explains the use of the counter when for measurement in conjunction with the oscilloscope.

2-6-1 Operation for Frequency Measurement

The following explains frequency measurement operation and the internal operation checks associated with it.

Before beginning measurement, performance of the counter should be checked using the internal operation check function.

Internal Operation Checks

1. Switch power ON.
2. Push the CHECK switch and check that the base oscillator frequency of 10,000 MHz is indicated on the count display for each range as shown in Table 2-3.
3. If the count display appears as shown in Table 2-3, all circuits (except input circuits) are operating normally.

Table 2-3

Range	Count	Unit
0.01	10000.0 ± 1	kHz
0.1	10000.00 ± 1	kHz
1	10000.000 ± 1	kHz
10	Δ0.000.0000 ± 1	kHz

Reference : Δ 0.000.0000

↑ indicates that the maximum number of digits on the scale has been exceeded.

Measuring the Frequency of a Signal Input to the Oscilloscope

1. Connect the signal to be measured to the CH1 INPUT.
2. Set the vertical MODE to CH1 and HORIZ DISPLAY to A.
3. Select A sweep COUPLING and CH1 VOLTS/DIV ranges to suit the input signal.
4. Set A sweep SOURCE to CH1 and horizontal MODE to AUTO or NORM.
5. Adjust the A sweep LEVEL to set the input signal sync range in the center for accurate synchronization (unstable sync will result in an unstable count).
6. Set EXT-INT to INT and FREQ.
   The above operation will result in the signal to be measured being input to CH1 INPUT and the frequency counted and displayed.
7. LF-HF and range are set to suit the signal to be measured. Select the range so that it has the required number of digits for measurement.
8. The LF-HF switch permits measurement over a range of 0.1 Hz to 10 MHz at LF, and over a range of 1 MHz to 100 MHz at HF.

Measuring the Frequency of a Signal Input to the EXT INPUT 1M ~ 150 MHz Terminal

1. Switch power ON. No other operation is required.
2. Input the signal to be measured to the EXT INPUT 1M ~ 150 MHz terminal.
3. Set EXT-INT to INT and FREQ.
4. Set LF-HF to HF and set the range to suit the signal to be measured. Select the range so that it has the required number of digits for measurement.
5. Frequencies between 1 MHz and 150 MHz may be input to the EXT INPUT terminal.

2-6-2 Operation for Period Measurement

Measuring the Period of a Signal Input to the Oscilloscope

1. Connect the signal to be measured to the CH1 INPUT.
2. Set the vertical MODE to CH1 and HORIZ DISPLAY to A.
3. Select A sweep COUPLING and CH1 VOLTS/DIV ranges to suit the input signal.
4. Set A sweep SOURCE to CH1 and horizontal MODE to AUTO or NORM.
5. Adjust the A sweep LEVEL to set the input signal sync range in the center for accurate synchronization (unstable sync will result in and unstable count).
6. Set EXT-INT to INT and PERIOD.
   The above operation will result in the signal to be measured being input to CH1 INPUT and the period counted and displayed.
7. LF-HF and range are set to suit the signal to be meas-

ured. Select the range so that it has the required number of digits for measurement.

8. The LF-HF switch permits measurement over a range of 0.5 μsec to 10 nsec at LF, and over a range of 10 nsec to 1 μsec at HF.

Table 2-4

Range	1	10	100	1000
Count range	0.1 μS±1	0.10 μS±1	0.100 μS±1	0.1000 μS±1

Measuring the Period of a Signal Input to the EXT INPUT 1M ~ 150 MHz Terminal

1. Switch power ON. No other operation is required.
2. Input the signal to be measured to the EXT INPUT 1M ~ 150 MHz terminal.
3. Set EXT-INT to INT and LF-HF to HF and PERIOD.
4. Set the range to suit the signal to be measured. Select the range so that it has the required number of digits for measurement.
5. Frequencies between 1 MHz and 150 MHz may be input to the EXT INPUT terminal.

Caution

When LF-HF is set to LF and the signal being measured has a period of between 0.2 μsec and 0.4 μsec, the unit display will blink to indicate an alarm condition. In this case a longer period should be measured.

2-6-3 Operation for Time Interval Measurement

Display the input signal on the CRT, use brightness modulation to mark the portion to be measured, and then directly read the interval.

1. Connect the signal to be measured to the CH1 INPUT.
1. Set the vertical MODE to CH1 and HORIZ DISPLAY to A.
3. Select A sweep COUPLING and CH1 VOLTS/DIV ranges to suit the input signal.
4. Set A sweep SOURCE to CH1 and horizontal MODE to AUTO or NORM.
5. Adjust the A sweep LEVEL to set the input signal sync range in the center for accurate synchronization. Set A TIME/DIV to a range permitting the most convenient measurement.
6. Set TIME INT for the counter.
7. Use the START knob to position the start point for brightness modulation of the portion of the waveform to be measured on the CRT.
8. Use the STOP knob to position the stop point for brightness modulation.
9. Indicate the interval for the brightness modulated portion on the display.

Caution

If the brightness modulated portion is made too narrow (0.2 μsec to 0.4 μsec) with the START or STOP cursor, the unit display will blink to indicate an alarm condition. In this case a longer period should be set.

2-6-4 Operation for Delay Time Measurement

Displays the time between A sweep start point and B sweep start point (ie., delay time) when the delay waveform is expanded.

The signal to be measured is input to either CH1 or CH2 input and continuous delay or synchronized delay added (see "CRT Waveform Expansion" in the section on signal observation applications).

1. Set DELAY TIME. No other counter switches need be set.
2. Set HORIZ DISPLAY to A INTEN and use DELAY TIME MULT to set B sweep to the position to be measured. The delay time is indicated on the display.
3. The delay time display also includes continuous delay, synchronous delay and B (DLY'D).

Caution

When delay time is set to between 0.2 μsec and 0.4 μsec, the unit display will blink to indicate an alarm condition. In this case a longer delay time should be measured.

2-6-5 Operation for A EVENT IN DELAY TIME Measurement

Displays the number of A sweep trigger signals between A sweep start point and B sweep start point when the delay waveform is expanded.

Oscilloscope operation is the same as that described in 2-6-4 "Delay Time Measurement".

1. Set EXT-INT to INT and LF-HF to LF and A EVENT IN D TIME.
2. Set HORIZ DISPLAY to A INTEN. The number of A sweep trigger signals between A sweep start point and B sweep start point will then be indicated on the display.
3. The display of the number of trigger pulses also includes continuous delay, synchronous delay and B (DLY'D).

Caution

The count may stop when the TIME/DIV range is moved from fast to slow. In this case, push the RESET switch to return to normal count.

2-7 OPERATION OF DIGITAL MULTIMETER

This section explains the use of the digital multimeter for measurement of DC • AC voltage, resistance, DC • AC current.

Connect the lead to the LO-HI terminal and switch power ON.

2-7-1 Operation for DC·AC Voltage Measurement

1. Set the function switch to V.
2. When measuring AC voltage, set AC/DC to AC, and when measuring DC voltage, set it to DC.
3. Set the range to a value suited to the voltage to be measured (200 mV, 2 V, 20 V, 200 V, 2000 V).
4. The measured value unit will be indicated by the LED lit at the right of the display.
5. When the selected range is exceeded, the highest digit will be displayed as either 1 or −1.

2-7-2 Operation for Resistance Measurement

1. Set the function switch to Ω.
2. Set the range to a value suited to the resistor to be measured (200 Ω, 2 kΩ, 20 kΩ, 2000 kΩ and 20 MΩ).
3. The measured value unit will be indicated by the LED lit at the right of the display.
4. When the selected range is exceeded, the highest digit will be displayed as either 1 or −1.

2-7-3 Operation for DC·AC Current Measurement

1. Set the function switch to A.
2. When measuring AC current, set AC/DC to AC, and when measuring DC current, set it to DC.
3. Set the range to a value suited to the current to be measured (2 mA, 20 mA, 200 mA and 2000 mA).
4. The measured value unit will be indicated by the LED lit at the right of the display.
5. When the selected range is exceeded, the highest digit will be displayed as either 1 or −1.

Measuring Instructions

3-1 ADJUSTMENTS NECESSARY BEFORE MEASUREMENT

It may be necessary to adjust the adjusters on the front panel and bottom before attempting measurements in order to assure accuracy of measurements. In case of measuring with a probe, its phase adjustment is necessary. Whichever the case, the adjusting screwdriver (supplied as an accessory to the probes) may be used for adjustment purposes.

About 30 minutes of warmup is recommended for stabilizing operation before adjusting the controls and probe phase.

3-1-1 TRACE ROTATION Adjustment

Traces may become not parallel to the graticule lines on the CRT screen due to geomagnetic effect or other cause.

If that occurs, display a trace on the CRT screen, move it to the center of the screen with ↕ POSITION, and adjust the trace parallel to the graticule lines with TRACE ROTATION. Before making this adjustment, install the SS-5711D in the normal place of use for measurements.

3-1-2 GAIN Adjustment (CH 1, CH2)

Vertical deflection check and adjustment are necessary to assure accuracy of voltage measurements.

The check and adjustment method is as follows. Set VOLTS/DIV switch to 10 mV, and connect INPUT to the CAL 0.6 V output terminal with an accessory probe. Check that the amplitude of the waveform displayed on the CRT screen is 6 divisions. If it is not rating adjust it with the GAIN. (See Figure 2-5.)

3-1-3 X5 BAL Adjustment (CH 1, CH 2)

If ambient temperature fluctuations are variable, the vertical position of a trace may shift when ↕ POSITION is pushed or pulled.

If that occurs, adjust the X5 BAL while pushing and pulling ↕ POSITION so that the trace will not deviate from its vertical position. (See Figure 2-5.)

3-1-4 VARIABLE BAL Adjustment (CH 1, CH 2)

If ambient temperature fluctuations are variable, the vertical position of a trace may shift when the vertical deflection VARIABLE control is turned.

If that occurs, adjust the VARIABLE BAL while turning the VARIABLE control so that the trace will not deviate from its vertical position. (See figure 2-5.)

3-1-5 Probe Phase Adjustment

10 : 1 passive probe phase adjustment

The following probes can be used for the SS-5711D: Type SS-0012 (1.5 m long) with an attenuation ratio of 10 : 1; SS-0001 (1 m long), SS-0002 (1.5 m long), and SS-0003 (2 m long), the later three with an attenuation ratio of 1 : 1. (Those probes with an attenuation ratio of 1 : 1 are optional.)

A mismatched probe phase can result in measuring the wrong waveform. Be sure to correctly adjust the probe before use.

First, set VOLTS/DIV to 10 mV, connect the probe to INPUT and the CAL 0.6 V output terminal so that a calibration voltage waveform with an amplitude of 6 divisions is displayed on the CRT screen.

Next turn the variable capacitor of the probe. The waveform changes as shown in figure 3-1 b or c. Adjust the variable capacitor correctly until the waveform is as shown in Figure 3-1 a.

Current probe sensitivity check

When using a current probe for measurement, check its sensitivity beforehand.

Read the instruction manual for the current probe for the checking procedure. The SS-5711D has the CAL 10 mA current loop terminal on the rear panel, where a square wave current of 10 mA flows in the arrow direction.

3-2 MEASUREMENT BY OSCILLOSCOPE

3-2-1 Voltage Measurement

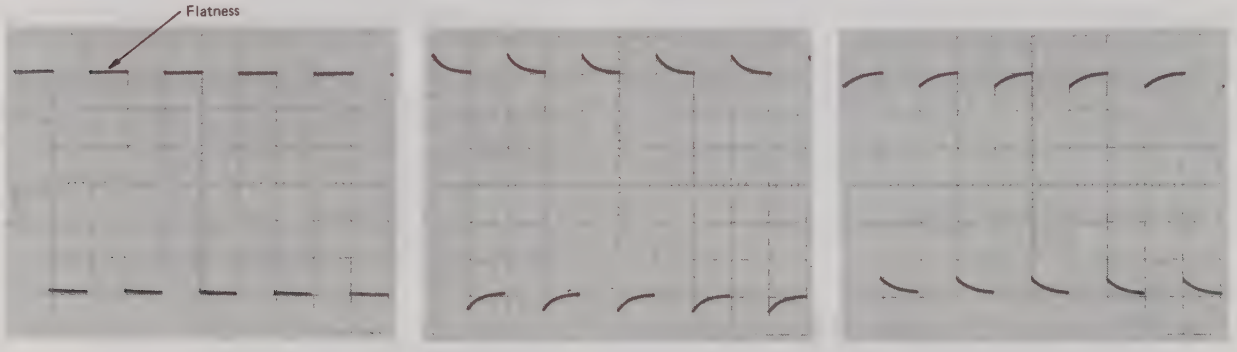
Quantitative Measurement

The quantitative measurement of voltage can be made by setting the VOLTS/DIV VARIABLE control to the CAL position. The measured value can be calculated by Equation (3-1)or (3-2).

a. Measurement with the x1 position of the probe:
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div) . .(3-1)

b. Measurement with the x10 position of the probe:
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div) x10. . (3-2).

Figure 3-1. Probe phase waveforms



a. Correct compensation b. Excessive compensation c. In sufficent compensation

Figure 3-2. DC voltage mesurement

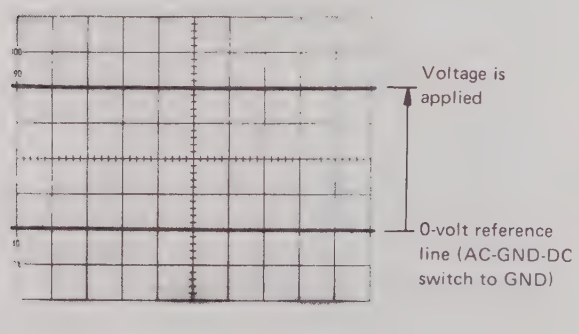
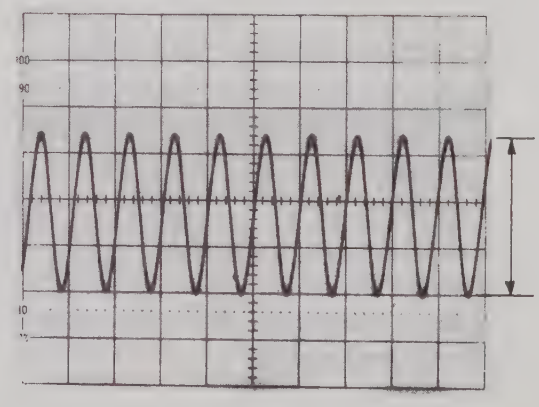


Figure 3-3. AC voltage measurement



DC Voltage Measurement

This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO, and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Figure. 3-2. Adjust the vertical POSITION control in order to place the trace exactly on a horizontal graticule, which facilitates the reading of signal voltage.
3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (3-1) or (3-2).

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows; Set the VOLTS/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Figure 3-3 and calculate by Equation (3-1) or (3-2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3-3).

$$\text{Effective voltage (V rms)} = \frac{\text{Peak voltage (Vp-p)}}{2\sqrt{2}} \quad \ldots (3\text{-}3)$$

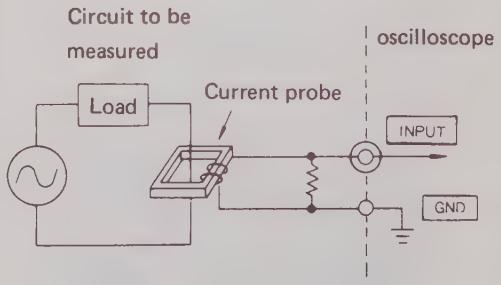
3-2-2 Current Measurement

Phanomena that can be observed by direct input application to the oscilloscope are voltage phenomena. All electrical phenomena other than voltage phenomena, such as mechanical vibrations and all others, require conversion into voltages for applying to INPUT.

In current measurements, a resistor of a known value is added to the circuit to be measured, and voltage variations at both ends of the resistor are observed on the CRT screen of the oscilloscope. The current value is calculated from the relationship V = IR. The resistor to be added to the circuit must have a resistance within a range in which the circuit will not change in operating condition. In case a resistor cannot be added to the circuit to be measured for reasons of operation, a current probe may be used for measuring currents without disconnecting the circuit. As shown in Figure 3-4, the current at the measuring point is detected by the core and secondary winding, and is applied to the vertical deflection system of the oscilloscope.

When measuring a small current, the output of the secondary winding is amplified and then applied. When measuring a large current, a shunt is inserted to apply a divided current. Otherwise, the core will be saturated. This method, however, is subject to limitation in frequency bandwidth. That is, it is unusable for high-frequency signals. if the circuit is ungrounded, a signal inptut cannot assure accurate current measurement. That is, a differential input amplifier is necessary in that case. As mentioned in the paragraph on Operation for observation of the Sum of Two Signals or their Difference, the SS-5711D can be used for differencial observation. This capability may be used in the following way. Select the vertical mode ADD, and CH 2 POLAR INV. Connect a probe to CH 1 and CH2

Figure 3-4. Current waveform measurement with current probe



INPUTs, and its tips to both ends of the resistor inserted. Turn the VOLTS/DIV switches for CH 1 and CH 2 to the same position. The waveforms for both ends of the resistor, i, e., current waveforms, can now be observed.

3-2-3 Time Measurement

The time interval of two points on a signal waveform can be calculated as follows: Set the TIME/DIV VARIABLE control to CAL, read the setting values of the TIME/DIV and x5 MAG switches and calculate the time by Equation (3-4).

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x5 MAG setting value. . . . . (3-4)

Where, the reciprocal number of the x5 MAG setting value is 1 when the sweep is not magnified, and 1/5 when the sweep is magnified.

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Figure 3-4.
2. Set the TIME/DIV switch in order to make the easy observation of the signal.
3. Read the distance between centers of rising and falling edges, i.e., the distance between two points at which pulse edges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (3-4).

Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows.

1. Display the pulse waveform vertically and horizontally in the same manner as for the pulsewidth measurement procedure.
2. Turn the horizontal POSITION control in order to set the upper 10% point of the waveform on the vertical center line of the graticule. (In Figure 3-5, the upper 10% point is 0.4 division below the top of the pulse since the displayed amplitude is 4 divisions.) Read the distance T_1 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
3. Shift and set the lower 10% point of the waveform to the vertical center line of the graticule as shown by the dotted line in Figure 3-5. Read the distance T_2 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.

Figure 3-5. Pulse width measurement

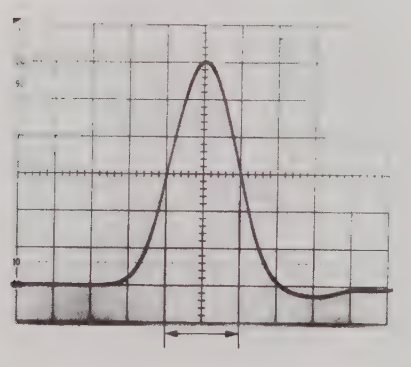
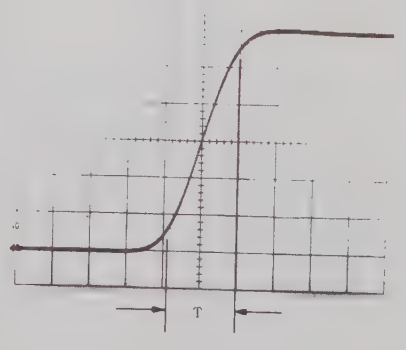


Figure 3-6. Rise (or fall) time measurement



4. Calculate the rise (or fall) time by substituting the sum of T_1 and T_2 for Equation (3-4).

3-2-4 Frequency Measurement

Of the frequency measurement procedure, there are the following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (3-4) as shown in Figure 3-6, and obtain th frequency by Equation (3-5).

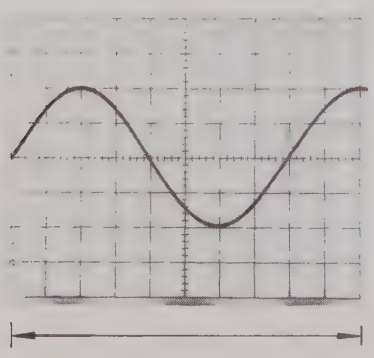
$$\text{Frequency (Hz)} = \frac{1\ (c)}{\text{Period (s)}} \quad \ldots\ldots\ldots\ldots\ldots (3\text{-}5)$$

The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (3-6).

$$\text{Frequency (Hz)} = \frac{N\ (c)}{\text{TIME/DIV setting value (s/div)} \times 10\ \text{(div)}} \quad \ldots (3\text{-}6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the count below decimal point becomes very ambiguous, which results in considerable error.

Figure 3-7. Frequency measurement (1)



For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the follwing method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pattern by applying the signal of which frequency is known, and read the necessay value.

3-2-5 Phase Defference Measurement

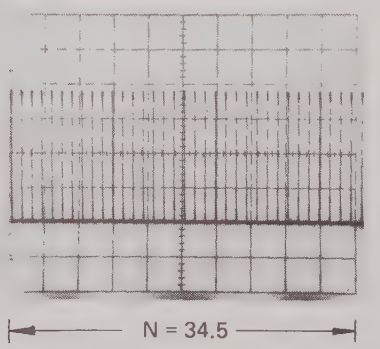
Of the measurement of phase difference between two signals, there are the follwing two methods:

The first one is the Lissajou's pattern method by using the instrument as an X-Y scope. The phase difference of signals can be calculated form the amplitudes A and B of the pattern shown in Figure 3-8 and by Equation (3-7).

$$\text{Phase defference (deg)} = \sin^{-1}\frac{A}{B} \quad \ldots\ldots\ldots (3\text{-}7)$$

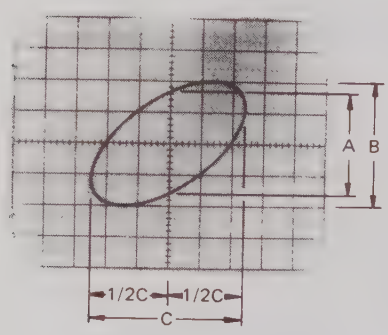
The second method is an application of dual-trace function Figure 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the SOURCE switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the displayed sine wave may be 9 divisions.

Figure 3-8. Frequency measurement (2)



Then, 1-division graticule represents a waveform phase of 40° (1 cycle $=2\pi=360°$). The phase difference between the two signals can be easily calculated by Equation (3-8).

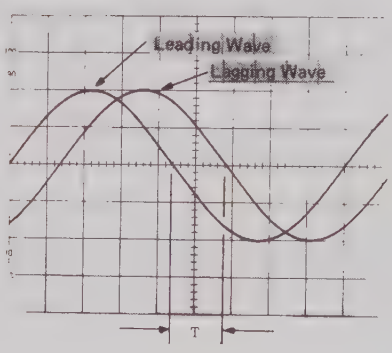
Figure 3-9. Phase difference measurement using Lissajou's pattern



Phase difference (deg)=T (div) x40°. . . . . (3-8)

Where, T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.

Figure 3-10. Phase difference measurement by dual-trace display



3-3 MEASUREMENT BY COUNTER

This section explains the measurement errors which occur when the counter is used for various measurements.

Refer to the previous section on use of the counter.

3-3-1 Frequency Measurement

Set to FREQ and ensure that the waveform on the screen is correctly synchronized.

Reference

When measuring frequency, a reduction in the range, and a consequent increase in the count time, will increase the number of effective digits in the display, and reduce the measurement error. The maximum accuracy is limited by the accuracy of the base oscillator.

Accurate measurement of low frequencies:

With frequencies which are so low that increasing the count time does not increase the number of effective digits on the display, measure the period and then convert it to a frequency.

Accurate measurement of rapidly varying frequencies:

With frequencies which varies rapidly, samples should be taken rapidly in succession with reduced count times so that the speed of the repeated counts is increased.

Measurement Errors

Frequency measurement is subject to both "base oscillator accuracy" and "± count" errors.

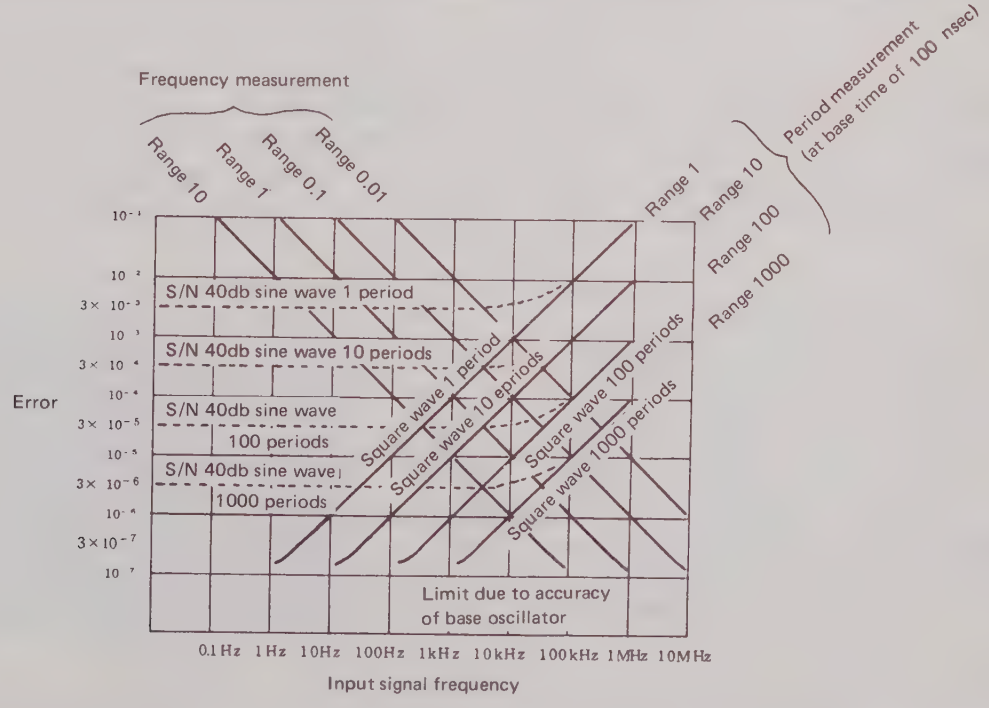
Base Oscillator Accuracy Error:

As the frequency measurement count time (gate time) and the period measurement base time (period of internal base pulse) are both produced by dividing the frequency of the base oscillator (crystal oscillator), their accuracy is determined by the accuracy of the base oscillator.

±1 Count Error:

Although digital measuring instruments are highly

Figure 3-11. Frequency vs. Error in Frequency and Period Measurements



accurate, they are subject to a ±1 count error which occurs when the gate is opened/closed for counting. When, for example, a 10.5 Hz input signal is measured with a 1 sec gate time, both 10 count and 11 count will occur so that an error of one count will occur despite the frequency being the same.

The relationship between the frequency of the input signal after correction of the base oscillator (period), and the error occuring, are shown in Figure 3-11.

For example, the ± count error when a 1 kHz frequency is measure with a 1 sec gate (range set to 1) is 10^{-3} (1 kHz x 10^{-3}) so that an error of ±1 Hz occurs. In this case 0.999 kHz, 1,000 kHz, or 1.001 kHz will be displayed. In this case, the accuracy based on the base oscillator accuracy is above the limit and may therefore be ignored.

3-3-2 Period Measurement

Set to PERIOD, all other operation is the same as with frequency measurement.

Measurement Errors

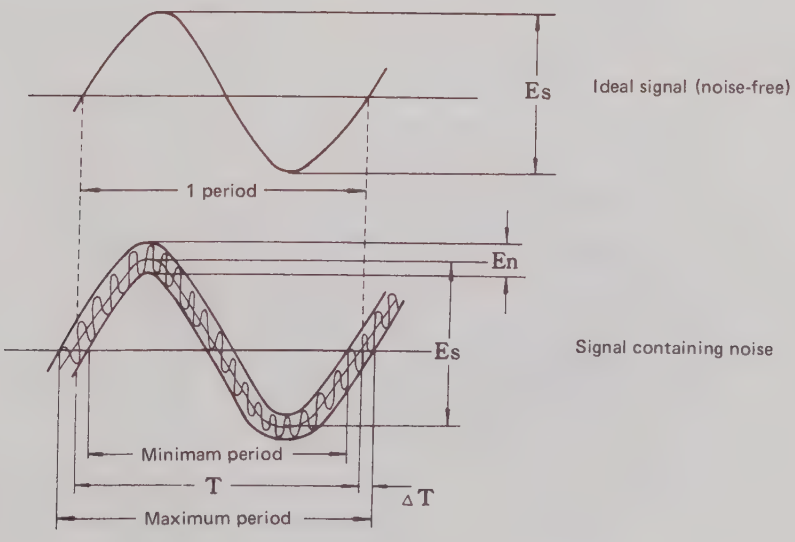
Period measurement is subject to both "base oscillator accuracy" and "1 base time/number of measured periods" errors. The "base oscillator accuracy" error is as previously described.

1 Base Time/Number of Measured Periods Error:

As with frequency measurement, a ±1 count error also occurs with period measurement (termed the 1 base time). With period measurement, this error may be reduced to [1/number of measured periods] by measuring more than one period so that the term "1 base time/number of measured periods" is used.

If, for example, a signal having a period of 1.00 μsec is measured for a base time of 10 n sec, 0.99 μsec, 1.00 μsec, or 1.01 μsec will be indicated on the display, and the ±1 base time error will be ±1%. When this is averaged over 10 periods, the error will result in the decimal point being moved one digit to the left so that 0.999 μsec, 1.000 μsec, or 1.001 μsec will be indicated on the display, and the ±1 base time error will be reduced to ±0.1%.

Figure 3-12. Trigger Error



Trigger Error/Number of Measured Periods Error:

With both period and interval measurement in which the gate is opened/closed with an input signal, gate time errors occur, and measurement accuracy is limited, due to noise superimposed on the input signal waveform, and to internal counter noise. These errors are termed trigger errors and are reduced to 1/1, 1/10, 1/100, 1/1000 according to the number of periods measured.

Trigger errors are described in detail below using a sine wave as an example. Measurement errors resulting from trigger errors are generally proportional to the noise level, and increases in inverse proportion to the slope of the input signal waveform trigger level. As shown in Figure 3-12, the trigger error with a sine wave is at a minimum when the trigger level is set at the center of the waveform. The relationship between input signal voltage and noise voltage error is shown by the following equation.

$$\frac{2\Delta T}{T} = \frac{1}{\pi} \times \frac{En}{Es} \left(\because \frac{En}{\Delta T} - \frac{2\pi Es}{T} \right)$$

As it is obvious from this equation, the relationship in the case of a sine wave is determined only by the ratio between the signal components Es (noise-free) and the noise En, it is unrelated to frequency. If, for example, the S/N ratio is 40 dB, the error as calculated with this equation will be 0.3%, if it is 60 dB, the error will be 0.03%. If the input signal is passed through a frequency dividing circuit and the average period N measured, the error will be reduced to 1/N as calculated by the following equation.

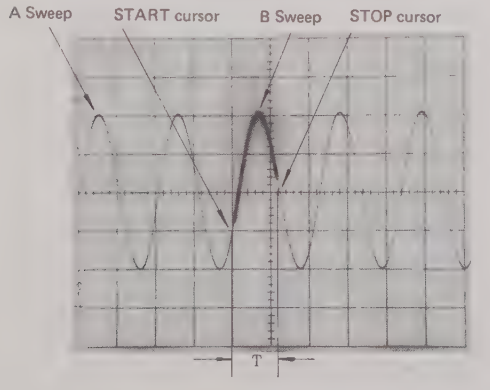
$$\frac{2\Delta T}{NT} = \frac{1}{\pi} \times \frac{En}{Es} \times \frac{1}{N}$$

Measurement of the average of a number of periods is therefore beneficial in reducing the effects of noise. For this reason therefore, this counter is designed to permit average measurement of 10, 100, and 1000 periods.

The relationship between input signal frequency (period) and error is shown in Figure 3-11, S/N 40 dB sine waves are shown by dotted lines, and square waves by the solid siles rising to the right.

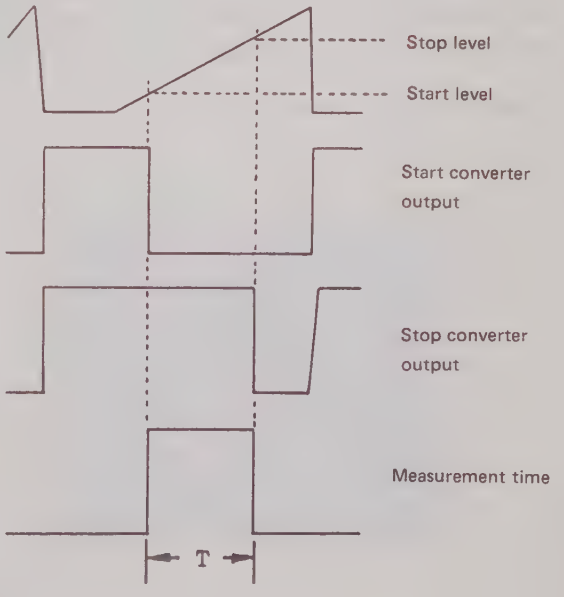
If, for example, a 1 kHz square wave input signal is measured for one period the error will be 10^{-5} (ie., 1kHz period x 1000 μsec) x 10^{-5} = 10 nsec, which is an error of ±0.01 μsec). In this case, 999.99 μsec, 1000.00 μsec, or 1000.01 μsec will be indicated on the display. If the input signal is measured for 10 periods the error will be reduced to 10^{-6} (±1 nsec). If a 1 kHz sine wave signal having a S/N

Figure 3-13. Time Interval Measurement



T : Portion to be measured (time)

Figure 3-14. Relationship of Measurement Time and Level



T is brightness modulated on the CRT.

of 40 dB is measured for one period, the error will be 0.301% [the sum of the trigger error (0.3%) and the ±1 base time error (0.001%)]. The error based on the accuracy of the base oscillator will be in accordance with number of digits in the display (as is the case with frequency measurement).

3-3-3 Time Interval Measurement

Input the signal to be measured to the oscilloscope, display it on the CRT, and synchronize it. Set the TIME INT switch and then set the START and STOP cursors at the portion to be measured. (See Figure 3-13.)

The marker brightness modulation portion interval T will be indicated on the display.

Measurement Error

Measurement of interval with the oscilloscope differs from the counter in that any interval on the oscilloscope A sweep waveform may be selected. The error is therefore not that of the measured signal, but is determined by sweep waveform jitter and linearity, and noise etc. emitted from the comparator circuit used for the cursor.

It therefore follows that the error when measuring interval is a maximum of ± (A sweep rate x 10 div x 3/1000) ±0.2 μsec. This is the error when an interval of 10 div on the screeen is measured, the error is a maximum of 0.3% ±0.2 μsec, 1 div having a maximum of 3% ±0.2 μsec, and 0.1 div, a maximum of 30% ±0.2 μsec.

As the measurement clock is fixed at 0.1 μsec, the ±0.2 μsec item is ±0.2 counts. As this value indicates the accuracy of the cursor, the error will increase to the degree to which the cursor is not aligned with the portion of the waveform to be measured on the CRT. As the two must be aligned by eye, particular care is required.

Figure 3-14 shows the relationship between the interval to be measured, comparators, and levels.

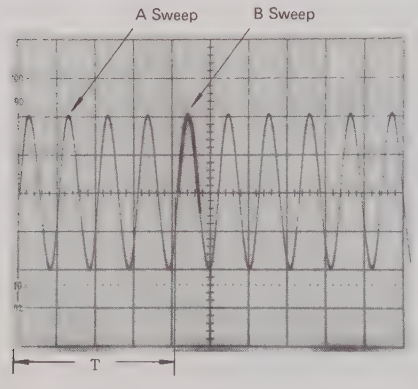
3-3-4 Delay Time Measurement

Input the signal to be measured to the oscilloscope, set delay operation, set DELAY TIME MULT for the portion to be measured, and then set the counter DELAY TIME switch (See Figure 3-15). The delay time T will appear on the display.

Measurement Error

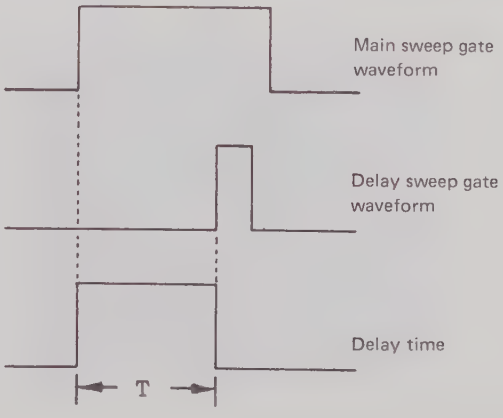
Delay time is the time between the start points of A sweep and B sweep and is meausred by using A and B sweep gate waveforms as start and stop signals respectively. The measurement error is therefore determined by A and B

Figure 3-15. Delay Time Measurement



T : Portion to be measured (time)

Figure 3-16. Relationship of Delay Time and Gate Waveform



T is indicated on the display

sweep waveform jitter etc.

The maximum error is as follows.

$$\pm(\text{A sweep rate} \times 10 \text{ div} \times 2/1000) \pm 0.2\ \mu\text{sec}$$

This is a maximum error of 0.2% ±0.2 μsec when a delay time of 10 div on the CRT is measured (2% ±0.2 μsec with 1 div, 20% ±0.2 μsec with 0.1 div).

As the measurement clock is fixed at 0.1 μsec, the ±0.2 μsec is ±2 counts.

Figure 3-16 shows the relationship between delay time and gate waveforms.

3-3-5 A EVENT IN DELAY TIME Measurement

Input the signal to be measured to the oscilloscope, set delay operation, set DELAY TIME MULT for the portion to be measured, and then set the A EVENT IN D TIME switch (See Figure 3-18). The number of A sweep trigger pulses between A sweep and B sweep start points will then be counted and indicated on the display.

Measurement Error

The error when A sweep trigger pulses are counted is as follows.

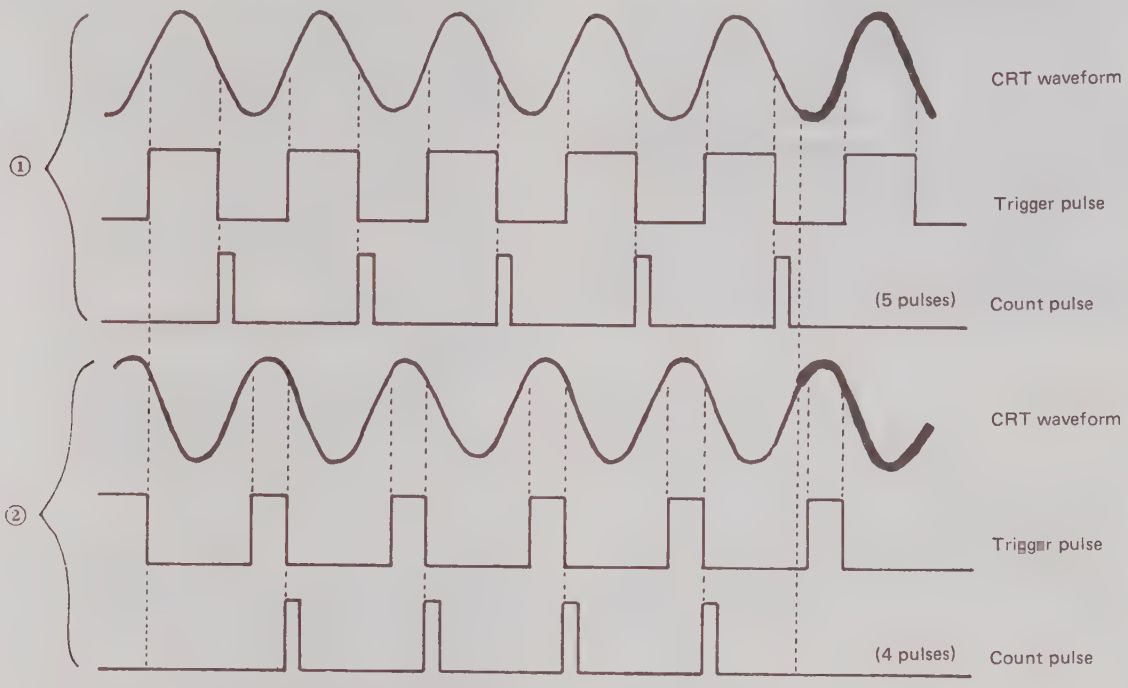
$$\pm\left(\frac{\text{A sweep rate} \times 10 \text{ div} \times 2/1000}{\text{period of A sweep trigger signal}}\right) \pm 1 \text{ count}$$

The reason for this error

When SOURCE is set to RUNS AFTER DELAY the delay sweep start is not synchronized with the trigger so that the count varies due to the DELAY TIME MULT position and trigger level position. The maximum value in this case is ±1 count.

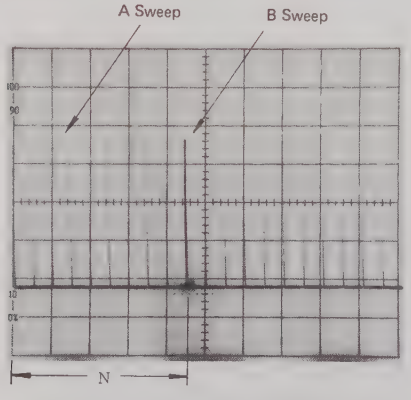
Figure 3-17 shows the relationship between trigger level position and count pulse.

Figure 3-17. Relationship of Trigger Level and Count Pulse



Count variation due to trigger level

Figure 3-18. A EVENT IN DELAY TIME Measurement



N : Number of A trigger pulses for portion to be measured (number)

3-4 MEASUREMENT BY DIGITAL MULTIMETER

3-4-1 Preparations Before Measurement

Connect the leads to the LO-HI terminal (in this case connect the black lead to the LO terminal).

Resistance Measurement

Set the function switch to Ω, short the tip of the lead, and check that the value on the display is 000 when the range is switched from 200 to 20M. If 000 does not appear on the display, see SECTION 6 "Checks and Adjustment" for details of zero Ω adjustment and adjust accordingly.

Range Exceeded Indication

If the set range is exceeded when measuring voltage, current, or resistance, the highest digit is displayed as 1 or −1.

3-4-2 DC·AC Voltage Measurement

Set the function switch to V. When measuring AC voltage, set AC/DC to AC, and when measuring DC voltage, set it to DC.

Set the range to a value suited to the voltage to be measured (200 mV, 2 V, 20 V, 200 V or 2000 V). A maximum of 1100 VDC may be measured with DC voltage measurement, and 1100 VDC, or 750 Vrms, with AC voltage measurement.

3-4-3 Resistance Measurement

Ensure that the lead and the resistor lead or point to be measured are in proper contact so that contact resistance does not distort readings. Switches are set as follows.

- Set the function switch to Ω.
- Set the range to a value suited to the resistor to be measured (200 kΩ, 2 kΩ, 20 kΩ, 2000 kΩ or 20 MΩ).

The measured value unit will be indicated by the LED lit at the right of the display.

High Resistance Measurement

When measuring resistances of 1 MΩ or more, use the high resistance cable (optional) to prevent distortion of readings due to ham broadcasts and noise (See Figure 3-19).

3-4-4 DC·AC Current Measurement

Set the function switch to A. When measuring AC current, set AC/DC to AC, and when measuring DC current, set it to DC.

Set the range to a value suited to the current to be measured (2 mA, 20 mA, 200 mA or 2000 mA). A maximum of 2 A may be measured with both DC and AC current measurement.

Caution

As variations in the count may occur when measuring AC voltages having a frequency differing slightly from the commercial power supply frequency, the GND or guard terminal of the measured circuit (or device) should be connected to the GND terminal of the digital multimeter.

Figure 3-19. Cable for High Resistance Measurement (optional)

3-4-5 High Voltage Measurement (high voltage probe)

Use the high voltage probe (optional) when measuring DC voltages higher than 30 kV.

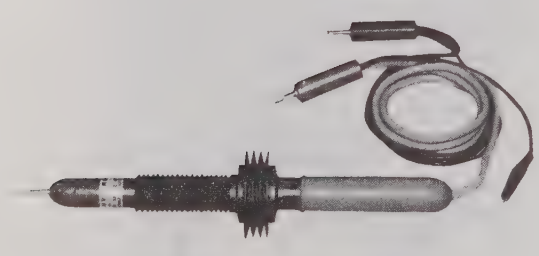
Specifications

Range	DC 10 V to 20 kV (20 V range)
	DC 100 V to 30 kV (200 V range)
Input resistance	1000 Ω approx.
Voltage division ratio	1000 : 1 (20 V or 200 V range)
Accuracy	±3% or less (20 V range)
	±5% or less (200 V range)
Maximum input voltage	35 kV for 1 minute
Operating temperature-humidity	0°C to 50°C 85% RH
Dimensions	Approximately 1.2 m (length including cord)

Installation

Connect the black corocodile clip to the GND terminal of the device to be measured, connect the red clamp to the HI input terminal, and the black clamp to the LO terminal.

Figure 3-20. Probe for High Voltage Measurement (optional)



Measurement

Set the function switch to V, AC/DC to DC, and range to 20 V or 200 V. Hold the probe (See Figure 3-20) by the red rubber cover and touch the tip to the high voltage section.

The value displayed at this time will be in kV.

Caution

Particular care should be taken to avoid electric shock when measuring high voltages. This is particularly important when measuring high voltage in devices with low internal resistance and large current capacities.
If the GND lead connected to the LO terminal becomes disconnected from the GND of the circuit being measured while high voltage (1100 V) is connected to the input terminal, the circuits in the multimeter will be damaged.
Always ensure that connections are positive.
Always set the range to 20 V or 200 V when using the high voltage probe. Measurement erros are increased with other ranges.

Circuit Description

The SS-5711D consists of the oscilloscope unit, universal counter unit, and digital multimeter unit.

The universal counter is electrically coupled with the oscilloscope, and the digital multimeter has an independent function. This section describes their operations and functions according to block diagrams.

For each block, the number in the box ☐ indicates the circuit number, so refer to the circuit diagram at Section 7.

For similar circuits such as the preamplifiers for CH1 and CH2 or the preamplifiers for CH3 and CH4, or the A and B trigger amplifiers, the following latter will be discribed only for the different items.

4-1 OSCILLOSCOPE UNIT

4-1-1 General Description

The circuit construction of the oscilloscope is shown in Figure 4-1-1. Each block is used for driving the CRT's electron beams finally.

Preamplifiers for channel 1, 2, 3, and 4

The vertical deflection system has four independent preamplifiers. The preamplifiers for CH 1 and CH 2 combine an attenuator (VOLTS/DIV switch), variable (VARIABLE control), and magnifier (PULL x 5 MAG switch) to permit input deflection factor setting from 1 mV to 12.5 V per division of the graticule scale. The simplified attenuator provided for CH 3 and CH 4 permits input deflection factor setting to 0.1 V or 1 V. As an input signal is applied to the INPUT connector for each channel, it is converted to a balanced signal, which is amplified and led to the delay cable driver circuit.

Delay cable driver circuit

The delay cable driver circuit leads the balanced signal from each preamplifier to the vertical main amplifier individually or by time division through diode gate opening and closing (switching circuit).

Modes of leading the balanced signal can be selected by setting the vertical MODE switch: CH 1 or CH 2 independent, display of the sum of CH 1 and CH 2 or the difference between them, two-channel (CH 1 and CH 2) display by time division, four-channel (CH 1 through CH 4) display by time division.

Multi-channel display by time division comes in two modes of operation: ALT and CHOP. ALT is the mode for changing display channels for every sweep of horizontal axis, and CHOP is the mode for changing display channels for every 500 kHz by the pulse from the built-in chop pulse generator. In the CHOP mode, a chop blanking pulse is applied to the Z-axis amplifier to erase the transient phenomenon during channel switching.

The selected display signals are guided to the delay cable.

The delay cable delays the passing signal by about 100 ns. The delayed signal is guided to the vertical output amplifier.

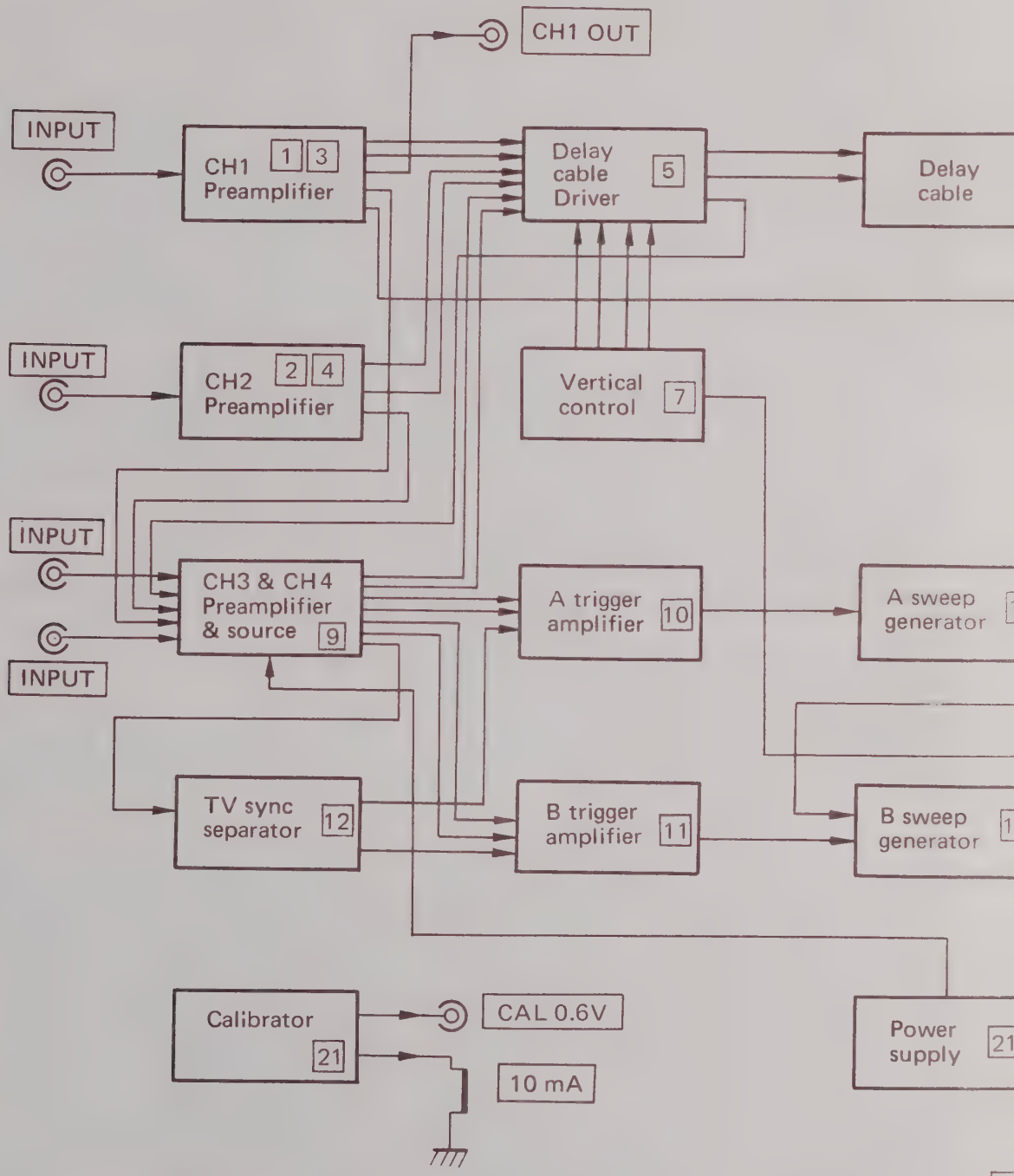
Vertical main amplifier

The vertical main amplifier is used for driving the electron beams which scan the fluorescent face of the CRT screen in the vertical axis (Y-axis) direction, and amplifies input signals up to the inherent deflection factor of the CRT to make the vertical input deflection factor correspondent to the CRT scale.

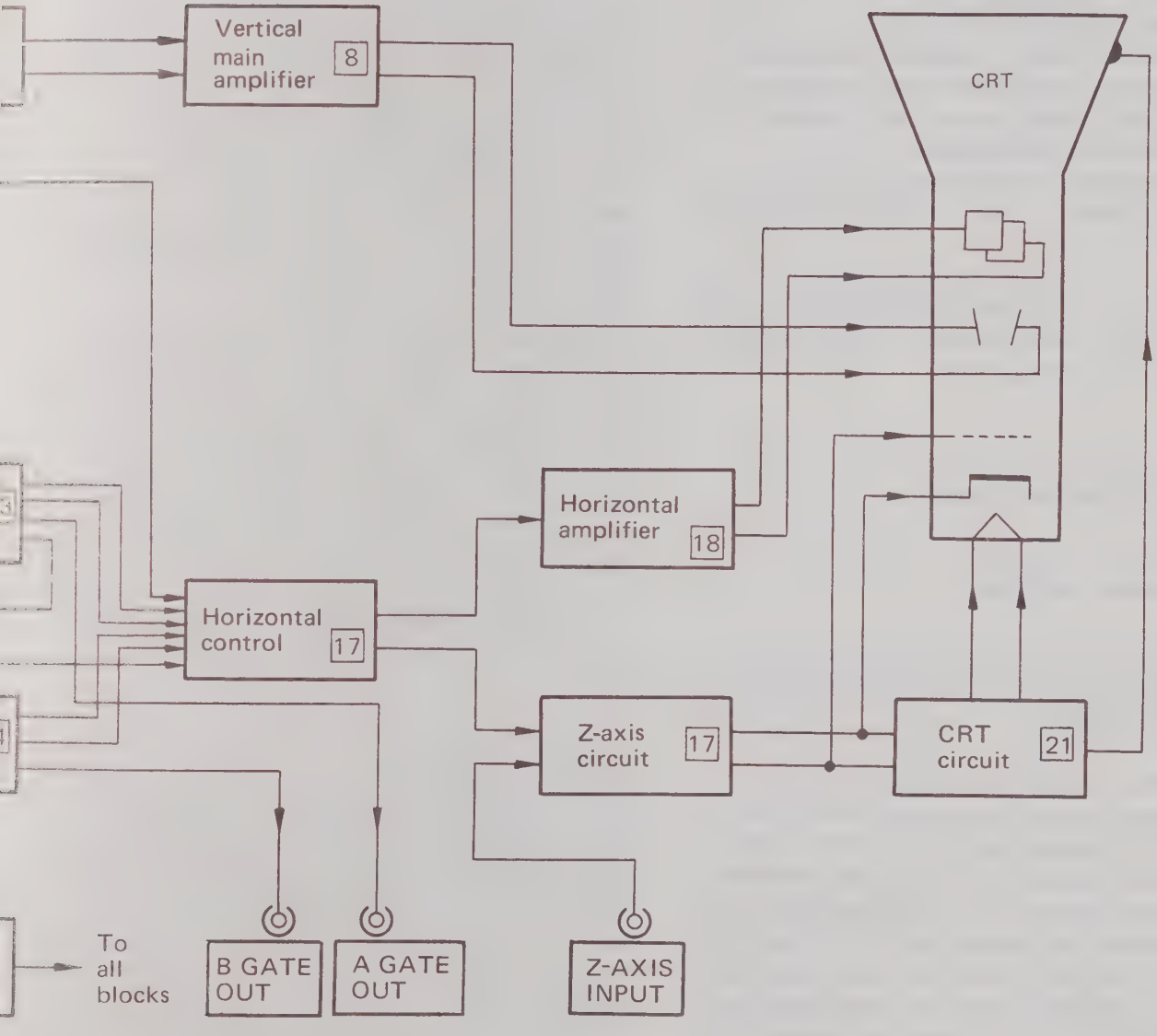
Trigger signal circuit

The signals branched out from the vertical preamplifiers are led to the trigger signal amplifier circuits via trigger signal switching circuits for CH 1, CH 2, CH 3, CH 4, LINE (from the power circuit) and NORM (from the main amplifier after its electronic switching) signals.

Figure 4-1-1. Block diagram of oscilloscope



For each block, the number in the box
schematic diagrams at Section 7.



indicates the circuit number, so refer to the

TV trigger signal separator circuit

Suppose that a television composite signal is applied to the vertical preamplifier. If the input is directly applied to the trigger signal amplifier circuit as it is, stabilized synchronization cannot be expected because the video signal component changes. Thus, the video signal component is removed by feeding the input through the TV trigger signal separator circuit, and the vertical trigger signal (TV-V) and horizontal trigger signal (TV-H) are separated by the time constant circuit composed of a resistor and capacitor. And after it, the stabilized synchronization is assured.

In TV trigger delay sweep, a horizontal trigger component is applied to the B trigger amplifier circuit.

A and B trigger amplifier circuits

The signals applied to the vertical preamplifiers are branched out and led to the A and B trigger amplifier circuits. Before reaching these amplifier circuits, however, the lowpass filter or highpass filter can be selected.

These trigger signals are applied to the A or B trigger amplifier circuit, where the signals are amplified to the proper sensitivity. The amplified signals are led to the sweep circuit via the pulse shaping circuit, which converts them to trigger pulses having a constant rise time and voltage.

A and B sawtooth generator circuits

The pulse generated by the A trigger pulse shaping circuit is applied to the A sawtooth generator circuit, and a sawtooth signal for horizontal axis sweep is generated when the sweep gate opens.

The B sawtooth generator circuit generates a sweep signal at a preset time after the operation of the A sawtooth generator circuit. The sweep by sawtooth B is called delayed sweep, which may be classified by the start timing of the B sawtooth generator circuit as follows:

Continuous delay sweep: Sawtooth B is generated when a pulse signal is generated by comparison of the voltage set with the delay multi-dial with sawtooth A.

Trigger delay sweep: Sawtooth B is generated by the first trigger signal B that reached after generation of a pulse signal by comparison of the voltage set with the delay multi-dial with sawtooth A.

As described above, sawtooth waveforms are generated by opening and closing the sweep gated, and sweep gate signals A and B generated at that time are led to the Z-axis amplifier.

Horizontal amplifier

The horizontal amplifier drives the electron beams which scan the fluorescent face of the CRT in the horizontal axis (X-axis) direction, and amplifies the input signals up to the inherent deflection factor to the CRT so that the trigger signals from the A and B sawtooth generator circuits will correspond to the time axis scale on the CRT screen.

Sweep signal A or B may be selected for the horizontal amplifier with the HORIZ DISPLAY switch A or A INTEN and B (DLY'D) input sweep signal A and sweep signal B respectively to the horizontal amplifier.

In ALT operation, sweep signals A and B are alternately selected by electronic switching every sweep, and input to the horizontal amplifier.

In X-Y operation, the signal input to the vertical preamplifier for CH 1 INPUT led is to the horizontal amplifier via the trigger amplifier and the signal applied to CH 2 INPUT is led to the vertical amplifier. Thus, a Lissajours' figure can be displayed on the screen, by the signal applied to CH 1 INPUT (X-axis display) and the signal applied to CH 2 INPUT (Y-axis display).

Z-axis amplifier

The Z-axis amplifier selects gate pulses from the A and B sawtooth generator circuits, amplifies the selected pulse, and generates a CRT intensity modulation signal. These gate pulses are called unblanking pulses bacause they eliminate retrace line.

The unblanking pulses vary in waveform according to HORIZ DISPLAY switch position. An unblanking pulse is generated from an A-gate waveform in the A sweep mode, from a combination o. A-gate and B-gate waveforms in the A INTEN mode, and from a B-gate waveform in the B (DLY'D) sweep mode. In ALT sweep, unblanking pulses with the INTEN waveform and B-sweep waveform are alternately provided to the HORIZ DIDSPLAY switch by electronic switching every sweep, and input to the Z-axis amplifier.

In addition, the aforementioned chop blanking signal for erasing the transient phenomenon during chopping, and the signal applied to Z AXIS INPUT for intensity modu-

lation from the outside are also provided to the Z-axis amplifier input.

If a positive signal of 0.5 V or more is applied to Z AXIS INPUT, the CRT luminance lowers to permit intensity modulation. The INTEN control for adjusting overall intensity is also connected to the Z-axis amplifier input.

CRT circuit

The CRT circuit consists of a circuit which generates heater voltages and high voltages for generating and accelerating electron beams, and grid circuits around the CRT for proper focusing.

Low-voltage circuit

The low-voltage circuit generates the stabilized low voltage from commercial AC power to drive each circuit, and also supplies a line trigger signal to synchronize with the commercial AC power and the CRT scale illuminating power.

Calibration voltage and current generator circuit

This is a constant-voltage constant-current square wave generator, and is set to a repetition frequency of about 1 kHz. Using the signal generated by this circuit, probe phases can be adjusted and oscilloscope input sensitivity can be calibrated. Current probe phases can also be adjusted by means of the current loop in the rear panel.

4-1-2 Vertical Deflection System

a. Signal input circuit and attenuator [1], [2]

A signal to be measured is either a very low-voltage, or a high-voltage, or ac voltage, or dc voltage, or a voltage of ac superposed on dc. The VOLTS/DIV switch is available to guide these signals either to the attenuator that amplifies the signal to an easy-to-observe amplitude. The AC/DC switch is selected the AC or DC connection to reject dc component, or to pass all components.

Using a probe or cable, the signal to be measured is applied to the INPUT connector. The maximum input voltage is 250 V (DC + peak AC when the signal is directly applied via cable, and 600V (DC + peak AC) when the signal is applied via a probe (10 : 1).

The AC/DC switch selects the type of the input coupling according to the signal applied to the connector. When the switch is set to AC, the input circuit of the vertical deflection system is made the ac coupling by IC01, so that dc component, if any, is blocked from the input signal and only ac component is passed.

When the switch is set to DC, the dc coupling is provided, thereby to pass the all frequencies including the dc component of the input signal.

When the switch is set to GND, the input signal is not connected to the attenuator, and the input of the attenuator is grounded. Thus, in this case, the input signal is not grounded, and therefore, the ground potential is easy to check.

The attenuator is used to attenuate the input signal properly. It permits the user to select the deflection factor of vertical deflection system in 10 ranges of 5 mV/div to 5 V/div. Also by using the x5 MAG, the 5 mV/div and 10 mV/div can be changed to high deflection factor of 1 mV/div and 2 mV/div respectively. Note, however, that the above defflection factor indicates the value when VARIABLE is set to CAL (full clockwise position).

b. Preamplifiers (CH1 and CH2) [1], [2], [3], [4]

The input signal must be amplified to the amplitude of the CRT's vertical deflection factor corresponding to the value set by the attenuator. The input signal, therefore, is amplified in the prestage; it is converted to the balanced signal and amplified by the symmetrical amplifier. In this case, in order to amplify the frequency of the input signal to the wide band width the amplifier is converted to a low-impedance output. The amplifier for this purpose is the preamplifier.

The preamplifiers for CH1 and CH2 have the circuit configuration as shown in Figure 4-1-2. The input signal is applied to the low-impedance converter 1Q11 via the attenuator. At this time, the input impedance is 1 MΩ, but, if the input signal is applied to the amplifier of high-impedance, it is difficult to have the wide frequency range, and therefor it is converted to a low-impedance. The input signals applied to the prestage-amplifiers 1Q13 and 1Q14 are amplified by the emitter-coupled symmetrical amplifier, and appears as the output of the opposite polarity, i.c, balanced signal (symmetrical waveform).

The signal is amplified by setting x5 MAG. If x1 is set, the amplifiers 1Q15 and 1Q16 do not function. The signals

amplified by the prestage-amplifiers are applied to the post-stage amplifiers.

The signals are applied via the low-impedance converters 3Q11 and 3Q12 to the post-stage amplifiers 3Q13 and 3Q14 and amplified. The amplified signals are shaped in 3Q21 and 3Q22 in the next stage. Also 3Q23 and 3Q24 are used to remove adverse mutual effect between the post-stage amplifier and the delay cable drive amplifier. VARIABLE (variable resistor) is installed between the collectors of the post-stage amplifier so that the deflection factor can be attenuated continuously to less than 1/2.5 of the indication value of the attenuator.

In the CH1 preamplifier, the output from the post-stage amplifier is branched, shaped and amplified, then guided as follows: CH1 OUT signal from the 3Q85 emitter and CH1 TRIG signal from the 3Q36 emitter to the trigger signal amplifier; X-Y signal from the 3Q42 collector to the horizontal-axis control circuit.

In the CH2 amplifier, the output from the post-stage amplifier is branched, shaped and amplified; then CH2 TRIG signal from the 4Q35 emitter is guided to the trigger signal amplifier.

The CH2 preamplifier has the CH2 POLARITY function enabling to invert the polarity of the signal applied to the INPUT of CH2. When NORM is set, the polarity applied to the 4Q25 emitter is not changed and outputs from the 4Q25 collector. When INVERT is set, the same polarity as that of the 4Q25 emitter is output from the 4Q23 collector and guided to the next stage. As a result, the signal is transmitted in the reverse polarity and applied to the deflection plate of the CRT.

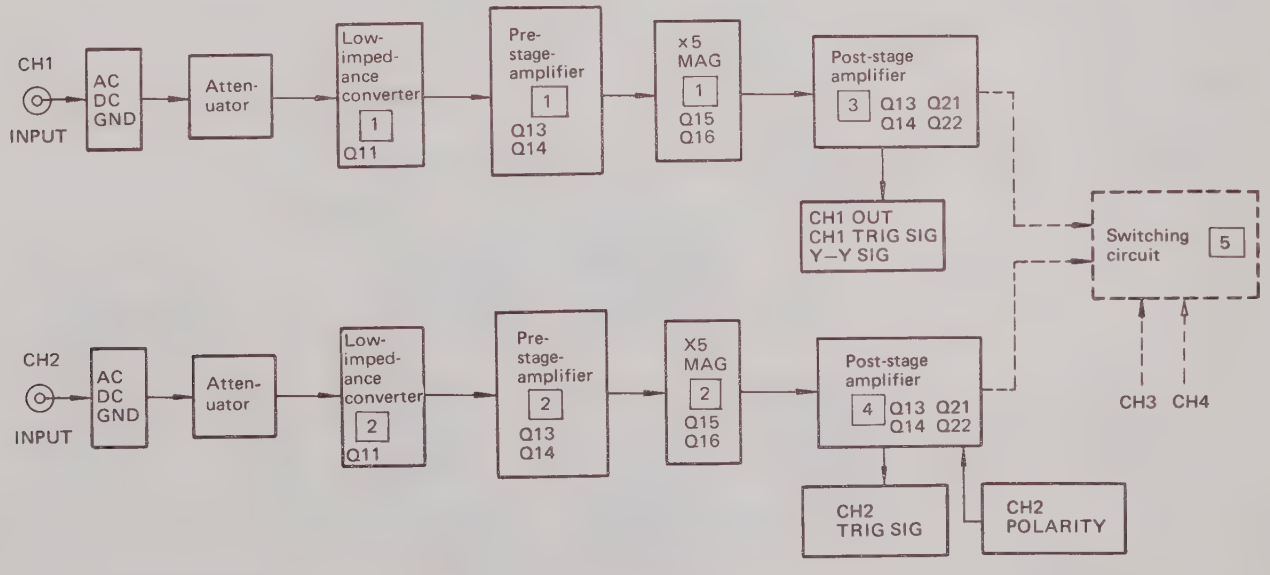
The POSITION Of CH1 is used to alter the collector voltages of 3Q21 and 3Q22 with its POSITION variable resistor and shift the vertical position of the waveform on the screen. And also, the POSITION of CH2 is used to alter the collector voltages from 4Q21 and 4Q22 with its POSITION varistor and shift the vertical position of the waveform on the screen.

c. Preamplifiers (CH3 and CH4) [5], [9]

The preamplifiers for CH3 and CH4 have the circuit configuration as shown in Figure 4-1-3. The input circuit operations and the preamplifier functions are the same as those of CH1 and CH2. Only the difference is that AC—DC switching is available but GND is not. The attenuator has only two-stages; 0.1 V/div and 1 V/div.

The input signal is applied via the attenuator to the gate of the low-impedance converter 9Q41 or 9Q71. The signal

Figure 4-1-2. Block diagram of CH1 and CH2 preamplifiers



on the low impedance is guided to the power amplifiers 9Q51 and 9Q53 or 9Q81 and 9Q83, then the power-amplified signals are applied to the preamplifiers 5Q11 and 5Q12. In the low-impedance converter, CH3 LEVEL ADJ is adjusted so that 0 V appears at the base of 9Q51 when the 9Q41 gate voltage is at 0 V. Also for CH4, CH4 LEVEL ADJ is adjusted.

The output of the power amplifier 5Q53 is branched and guided to A-SOURCE selector switch, then applied to the A trigger signal amplifier. For CH4, the output of 5Q83 is branched and guided to B-SOURCE selector switch, then applied to the B trigger signal amplifier.

d. Vertical MODE [5], [7]

The basic operations of switching circuit will be described below. See Figure 4-1-4.

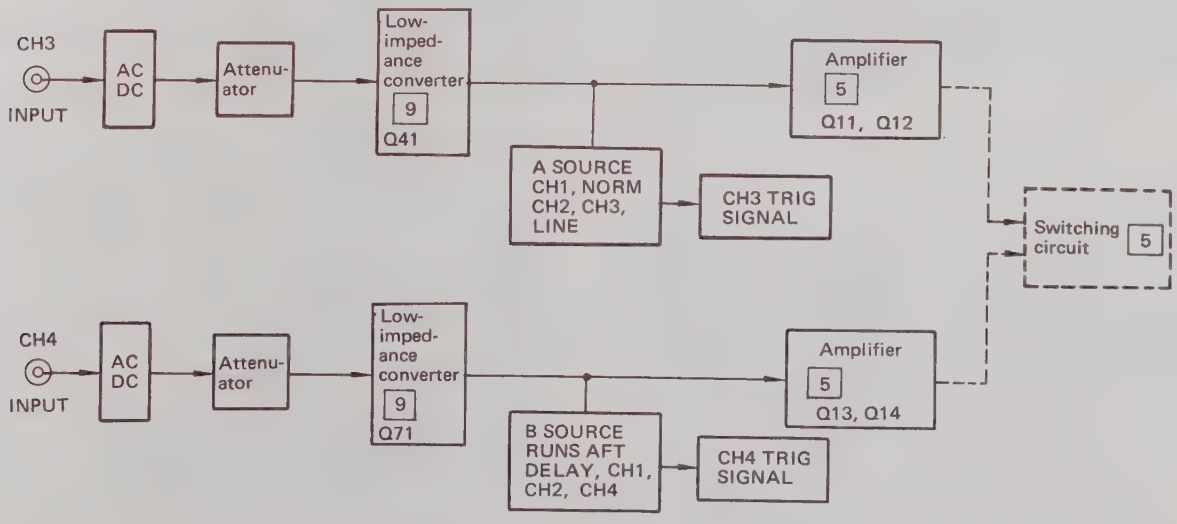
CH1: When the vertical axis MODE is set to CH1, a high-level voltage is applied via 7Q11 to the anodes of 5D15 and 5D16, which are forward biased and thus makes them ON. This raises the cathode potential, turning 5D17 and 5D18 OFF, and thus signal from CH2 cannot be passed. Meanwhile, a low-level potential is applied to the anode of 5D11 and 5D12, which are reverse biased and thus turned OFF. This makes 5D13 and 5D14 forward biased and makes them ON, so that the signal from CH1 only is guided to the amplifiers 5Q21 and 5Q22.

CH2: When the vertical axis MODE is set to CH2, a high-level voltage is applied via 7Q12 to the anodes of 5D11 and 5D12, which are forward biased and thus makes them ON. This raises the cathode potential, turning 5D13 and 5D14 OFF, and thus signal from CH1 cannot be passed. Meanwhile, a low-level voltage is applied to the anodes of 5D15 and 5D16, which are reverse biased and thus turned OFF. This makes 5D17 and 5D18 forward biased and makes them ON, so that the signal from CH2 only is guided to the amplifiers 5Q21 and 5Q22.

ALT: When the vertical axis MODE is set to ALT, alternate pulses of CH1 and Ch2 are sent, at each sweep of respective horizontal axis from the horizontal axis control circuit to the vertical axis control circuit, and guided via 71C2 and 71C3 to the switching circuit. With the biasing functions of 5D11 to 5D18 of the switching circuit stated before, momentary ON/OFF switching operation is carried out similarly, so that CH1 and CH2 signals appear alternately on the CRT screen.

The ALT method is thus suited to observe two signals having relatively high frequencies.

Figure 4-1-3. Block diagram of CH3 and CH4 preamplifiers



CHOP: Wehn the vertical axis MODE is set to CHOP, 71C2 functions as an astable multivibrator. Its switching frequency is determined by the time constants of 7R21 to 7R24, 7C22 and 7C23. While 71C2 is repeating ON/OFF operation, switching CH1 and CH2, and repeating sweep with these time constants, the signals are guided to the delay cable drive amplifier.

This instrument switches ON and OFF at about 2 μs intervals (500 kHz), and therefore is suited to observe two signals having relatively low frequencies.

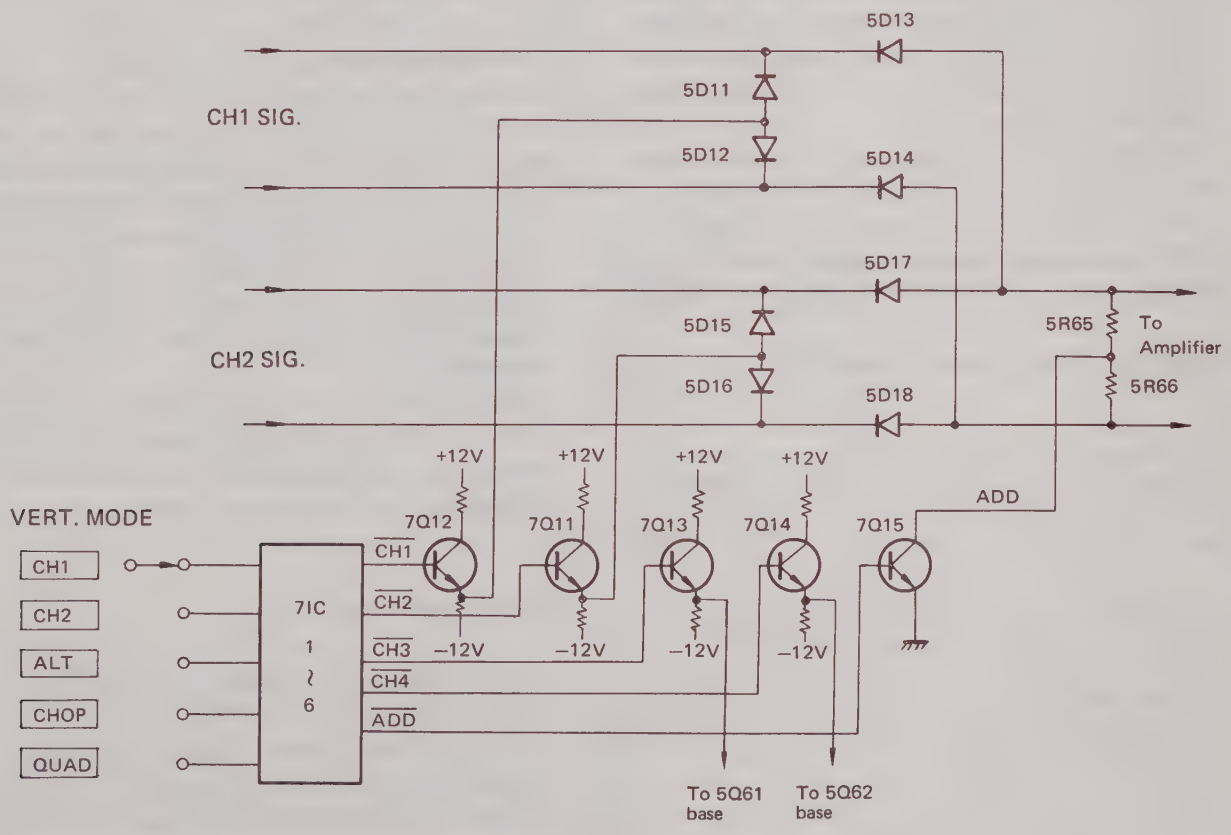
The chop blanking pulse removes transient phenomonon that occurs when CH1 and CH2 traces are switched. This pulse is guided to the Z-axis amplifier.

ADD: When the vertical axis MODE is set to ADD, the CRT displays the sum of the signals to be measured (CH + CH2) applied to CH1 and CH2 at the same time. The circuit functions to turn 7Q15 OFF in order to apply a high-level voltage to the anodes of 5D13 and 5D14 as well as 5D17 and 5D18 via 7R71, 5R75 and 5R77 as well as 5R72, 5R76 and 5R875.

Remember, at single CH1 or CH2, the current is shunted to 7Q15 via 5R65 and 5R66; but at ADD, the current is not shunted to 7Q15. As a result, 5D13, 5D14, 5D17 and 5D18 are forward biased and made ON, and the balanced signals of both CH1 and CH2 are guided to the delay cable drive amplifier at the same time. If CH2 POLAR switch is set to INV, the input signal polarity of CH2 becomes reverse and the output of the switching circuit appears on the CRT as the difference between the measuring signals applied to CH1 and CH2 [CH1 + (−CH2)].

QUAD: When the vertical axis MODE is set to either ALT or CHOP, and then set to QUAD, 4-phenomena appears, and

Figure 4-1-4. Switching circuit



then set to QUAD, 4-phenomena appears, and the CRT displays the input signals of CH1, CH2, CH3, and CH4. 4-phenomena at ALT.

When set to ALT, as in the case of ALT operation stated before, the traces from CH1 to CH4 appear alternately. During CH1 sweep, the switching circuits of CH2 to CH4 are OFF and sweep is halted. When CH1 sweep has finished, CH2 sweep starts, and other channels are OFF; then CH3 sweep starts with other channels OFF, and followed by CH4 sweep starts with other channels OFF. In this manner, the operation is repeated.

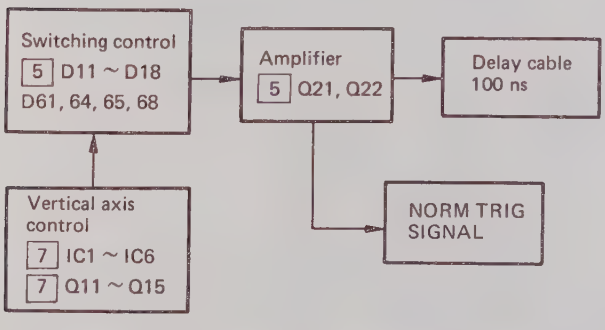
4-phonomena at CHOP: When set to CHOP, as in the case of CHOP operation stated before, the CRT displays the traces of four channels from CH1 to CH4. In this case, the switching frequency is about 250 kHz.

e. Delay cable drive amplifier [5]

The delay cable drive amplifier is shown in Figure 4-1-5. The amplifier receives the output signal of the preamplifier of CH1, CH2, CH3 or CH4, guides the signal to the switching circuit, so that the vertical axis mode is controlled by the vertical axis control circuit.

The balanced signal from the switching circuit is amplified by the next delayed cable drive amplifiers 5Q21 and 5Q22. The amplified signal is guided to the delay cable, where the transmittion time of the vertical axis is delayed, then is applied to the main vertical amplifier (the last stage amplifier). The output of the drive amplifier also is branched and shaped into NORM TRIG signal, then guided to A SOURCE switch.

Figure 4-1-5. Delay cable drive amplifier



f. Delay cable [5]

The delay cable drive amplifier stated before, together with the post-stage amplifiers of CH1 to CH4 preamplifiers, constitute the composite amplifier. This composite amplifier makes low impedance by the negative feedback with 5R71 and 5R75 or 5R72 and 5R76, to prevent degradation of frequency characteristics due to complex circuit configuration, and guides the signal to the delay cable.

The delay cable is inserted to delay the transmission time of the vertical axis so that the signals applied from the input of vertical axis will reach the vertical deflection plate and horizontal deflection plate almost simultaneously.

In order to observe the leading edge of the input signal waveform by the internal trigger, this device requires a delay time of about 100 ns.

g. Vertical main amplifier [8]

The vertical output amplifier, by means of the balance amplifier, amplifies the output signal from the delay cable, and converts the low-impedance input to a high-impedance output, then further amplifies the output to a sufficient amplitude to be deflected in the vertical direction of CRT, and applies to the vertical deflection plate of CRT.

The 8R10 is the variable resistor to compensate for impedance matching distortion between the delay cable and the amplifier.

The variable capacitors 8C53 and 8C54 between the emitters of 8Q21 and 8Q22 as well as the variable resistor 8R54 comprise the compensation circuit to prevent ringing or other distortion from appearing in the signal wave form.

4-1-3 Trigger Circuit

a. A and B trigger signal amplifier, [9] , [10] , [11] , [12] , [13] , [14]

The trigger signal amplifier permits the user to select the trigger signal source with SOURCE or to select the coupling of the trigger source and the trigger amplifier with COUPLING. It is also used to amplify the selected trigger signal to a sufficient amplitude as the trigger pulse signal.

Also, it serves as the circuit to separate TV-V and TV-H sync pulses from the composite video signal so that the TV composite video signal can be synchronized stably.

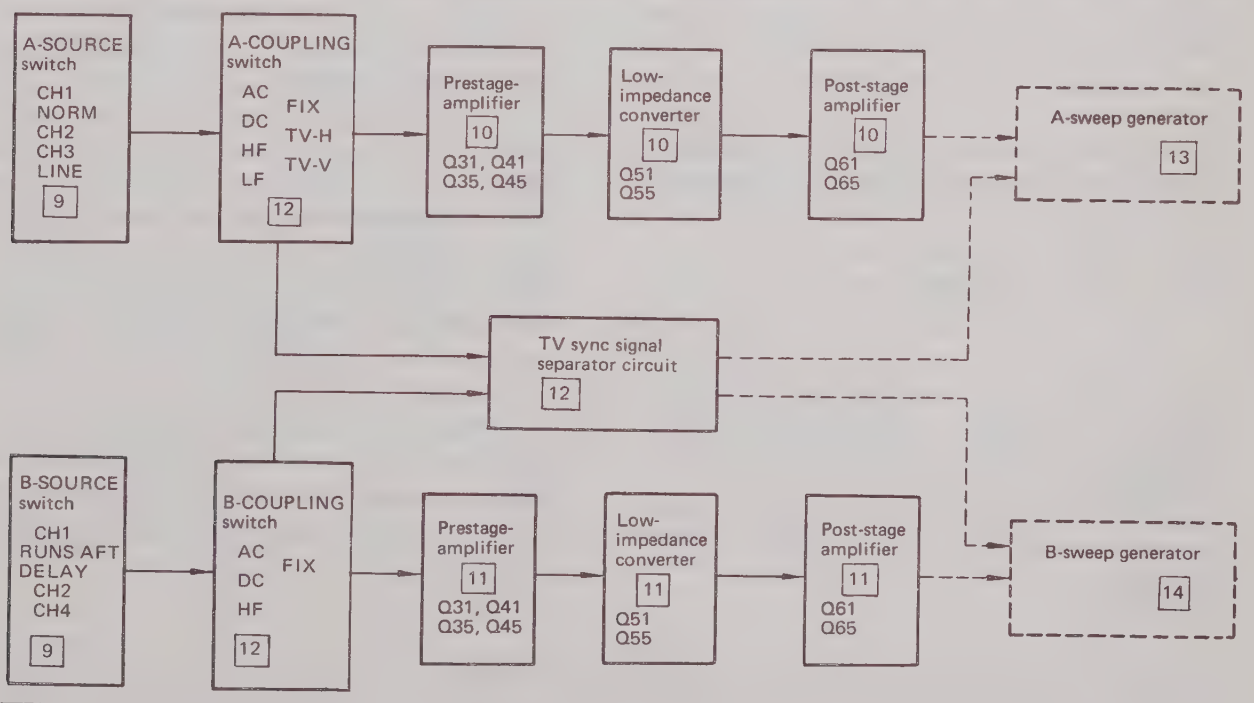
The trigger signal amplifier consists of the switch circuit to select the respective ranges of SOURCE and COUPLING, the prestage-amplifier, the converter to convert high-impedance input to low-impedance output, the post-stage amplifier, and the TV sync signal separator. These components are shown in Figure 4-1-6.

The SOURCE switch is used to select the trigger signal source. As stated before, for CH1, 2, 3, or 4, the signal applied to the input of vertical axis is branched and connected. At NORM, the signal displaying on the screen according to the vertical axis mode will become the trigger signal. at LINE, the power line signal is the trigger signal, and it is convenient to observe signals such as the line frequency and higher harmonics. At RUNS AFTER DELAY of B SOURCE, the B source is continuously delayed and other ranges are delayed synchronously.

The COUPLING switch is used to select the coupling type of the trigger signal source and the trigger signal amplifier. At AC, the AC coupling is selected and dc component is blocked by capacitor 10C1, and therefore, the trigger can be made independent of dc component. At DC, the DC coupling is selected and the trigger can be made beginning with dc. At HF REJ, 10C2 and 10R3 constitute a low-pass filter and attenuates frequency components of about 10 kHz or higher. This is convenient to observe signals containing high-frequency noise. At LF REJ, 10C12 and 10R13 constitute a high-pass filter and attenuates frequency components of about 10 kHz or lower. At FIX, the trigger level is fixed and therefore the operation for trigger level is unnecessary. TV-H drives the TV sync signal separater later described so that trigger is made with TV horizontal trigger pulse and the composite video signal waveform between 1H can be observed. The TV composite video signal waveform in B sweep can be observed by adding horizontal trigger pulse to the input of CH4.

In the trigger signal amplifier, low-frequency band components are amplified by 10IC1 and high-frequency band component, after passed through 10C12, is amplified respectively by prestage amplifiers 10Q31, 10Q35, 10Q41, and 10Q45. The amplified signal is guided to 10Q51 and 10Q55, converted from high-impedance input to low-

Figure 4-1-6. Block diagram of A and B trigger signal amplifiers



impedance output, and further amplified by post-stage amplifiers 10Q61 and 10Q65. The amplified signal is guided to A or B sweep generator.

The TV sync signal is guided via COUPLING switch to the base of the TV sync signal separator 12Q1.

b. TV sync signal separator circuit [10]

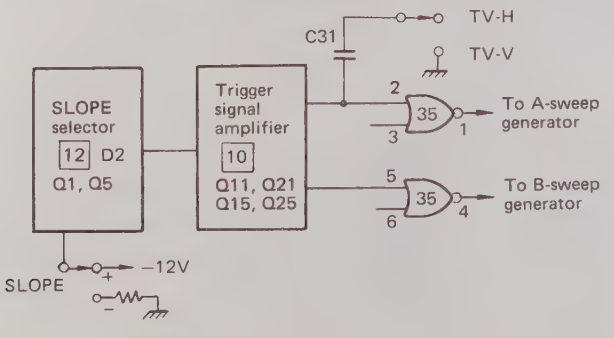
The TV sync signal separator is as shown in Figure 4-1-7. In this separator, only the sync signal is separated from the TV composite video signal and amplified, then the amplified sync signal is separated into the horizontal sync signal TV-H and the vertical sync signal TV-V. The separated TV-H and TV-V pulse signals are guided to the A-sweep generator; the TV-H pulse signal to the B-sweep generator.

This is carried out by selecting SLOPE so that the composite video signal applied to the base of 12Q1 is switched by ON/OFF operation of 12D2 and 12Q5. This operation determines whether the signal of the same polarity as applied to 12Q1 is to be guided from the emitter or the signal of opposite polarity is to be guided from the collector.

The circuits of 12Q11, 12Q15, 12Q21, and 12Q25 remove the video signal component and amplify only the sync signal component. Of the amplified sync signal, only TV-H pulse is guided from pin 4 of 12IC35 to the B sweep generator.

By connecting 12C31 to the middle of the pin 1 of 12IC31 and the ground, TV-V pulse signal is output from pin 1 of 12Q35; by disconecting 12C31, TV-H pulse signal is output from it and guided to the A-sweep generator.

Figure 4-1-7. Block diagram of TV sync signal separator circuit



4-1-4 Sawtooth-wave Generator Circuit

a. A-sweep generator, [13] , [15]

The A-sweep generator is as shown in Figure 4-1-8.

The A-sweep generator, by trigger pulse signal, generates sawtooth-wave for sweep (trigger sweep) triggered with the signal to be measured, or sawtooth-wave for sweep (self sweep) independent of trigger signal. It also outputs unblanking signal and gate signal to brighten the traces and to erase the refrace lines.

As Figure 4-1-9 shows, A-trigger signal and the polarity signal are applied to the Schmidt trigger comparator 13IC01. The A of 13IC01 shapes the waveform and outputs the trigger pulse signal. The B of 13IC01 switches the polarity of the trigger signal. The shaped trigger pulse signal and the polarity-changed signal are guided to the jitter free flip-flop 13IC01, 13IC05 and 13IC11. At the A of 13IC01, the size of hysterisis for shaping the trigger signal wave is determined by 13R3 and the output impedance of the trigger signal amplifier.

The sweep generator is designed to start sweep when the trigger pulse signal changes from Hi to Lo. As a result, the trigger polarity changes with the polarity of slope as shown in table 4-1-1.

From the jitter free flip-flop circuits 13IC01, 13IC05 and 13IC11, the gate signal is output at the time trigger pulse is received during waiting for sweep, and the sweep waiting condition is resumed when HOLD OFF signal is released. If the trigger pulse signal is repeated fast (about 1 MHz or more), a double trigger operaton occurs; and if slow, a single operation occurs (see Figure 4-1-11). Note, however, that if the trigger pulse signal is input during X-Y operation, the gate pulse is not output, and the sweep mode becomes normal condition. The gate signal is output from the pin 15 of 13IC05 and guided to the ECL to TTL converter 13Q15.

As Figure 4-1-10 shows, both 13IC05 are D-type flip-flop and the D signal is output by the input of clock signal (trigger pulse signal). The 13IC11 is a monostable multivibrator and its operation as double trigger or single trigger

Figure 4-1-8. Block diagram of A-sweep generator circuit

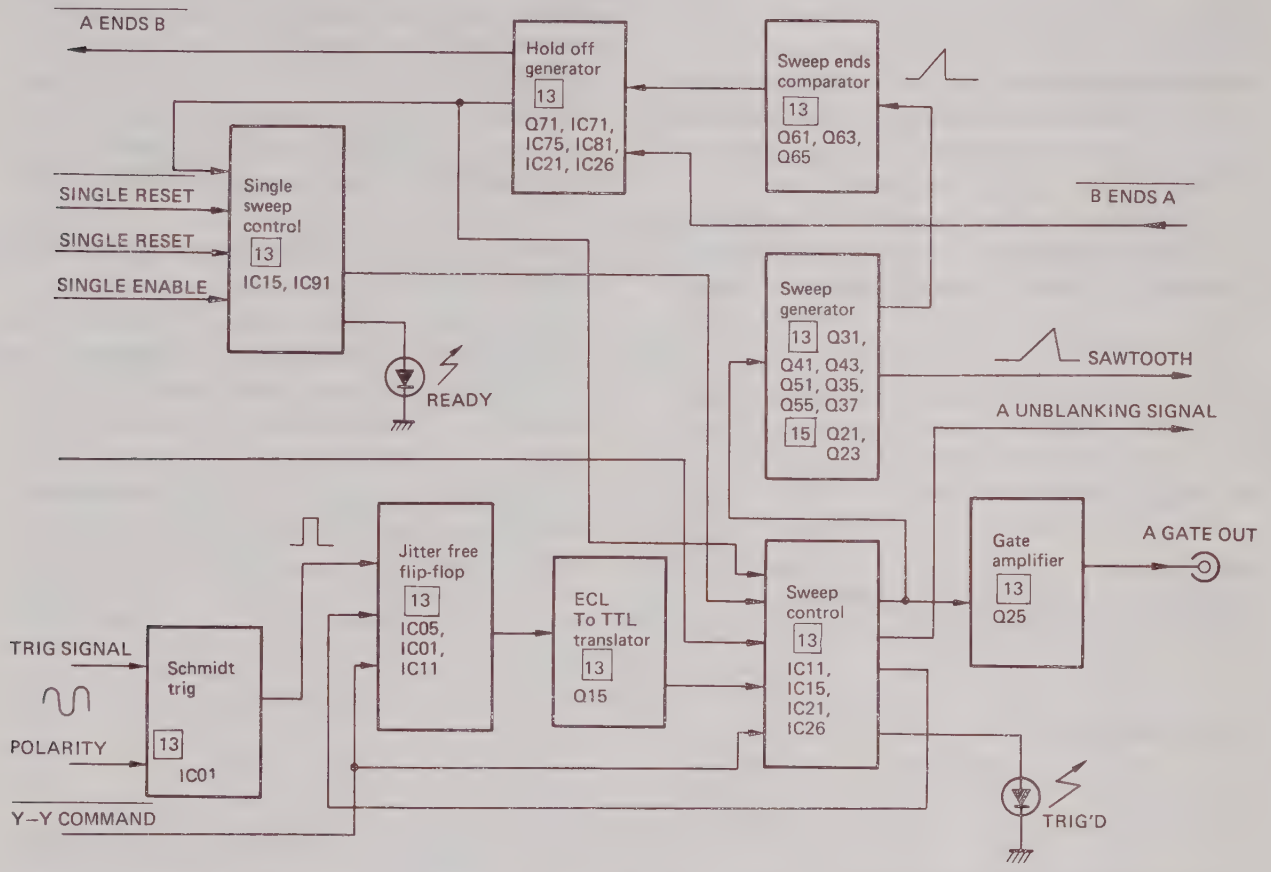


Table 4-1-1

Slope	Positive	Negative
POLARITY	Hi	Lo
A TRIG SIG	Hi ← Lo	Hi → Lo
OUT	Hi ← Lo	Lo → Hi

Figure 4-1-9. Polarity switching and waveform-shaping circuit

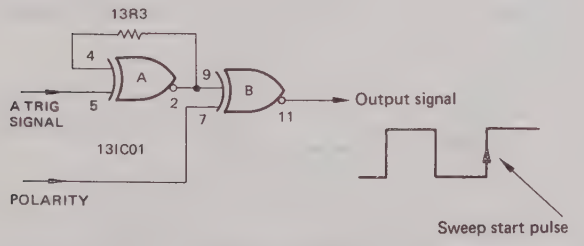


Figure 4-1-10. Jitter free flip-flop

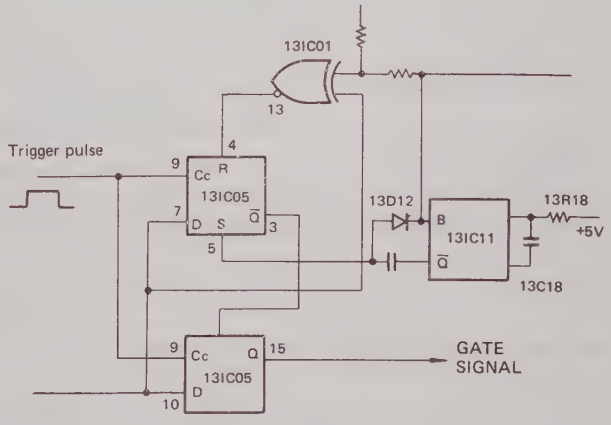
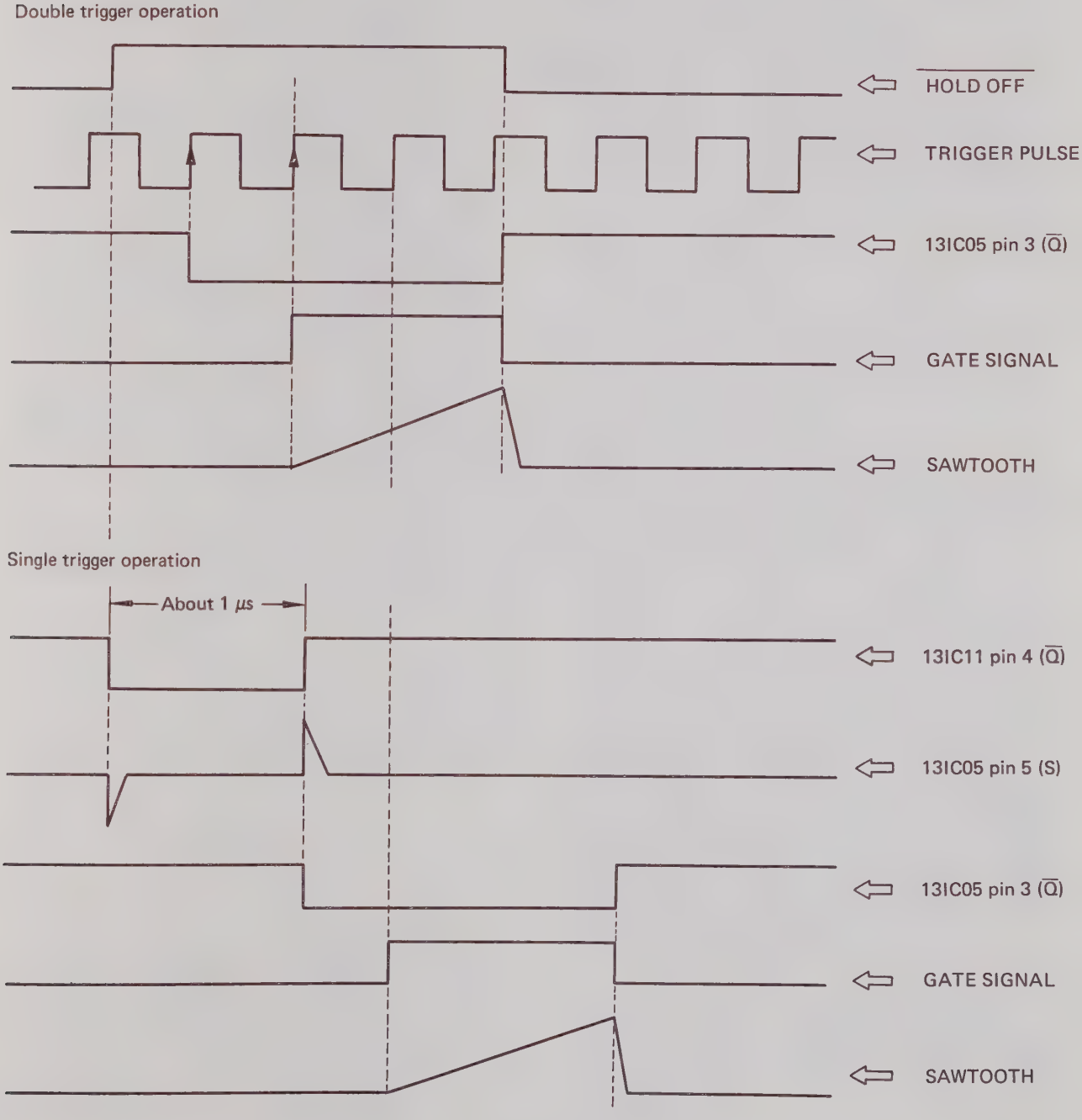


Figure 4-1-11. Timing chart



is determined by the repetition of trigger pulse signal (see Figure 4-1-11). The time constant of operation being selected is determined by 13R18 and 13C18. When the sweep mode is SINGLE, the 13D12 clears the output of the monostable multivibrator. This means only one sweep.

The 13Q15 causes the ECL level applied to the base to be converted to TTL level and guided to the sweep control circuits.

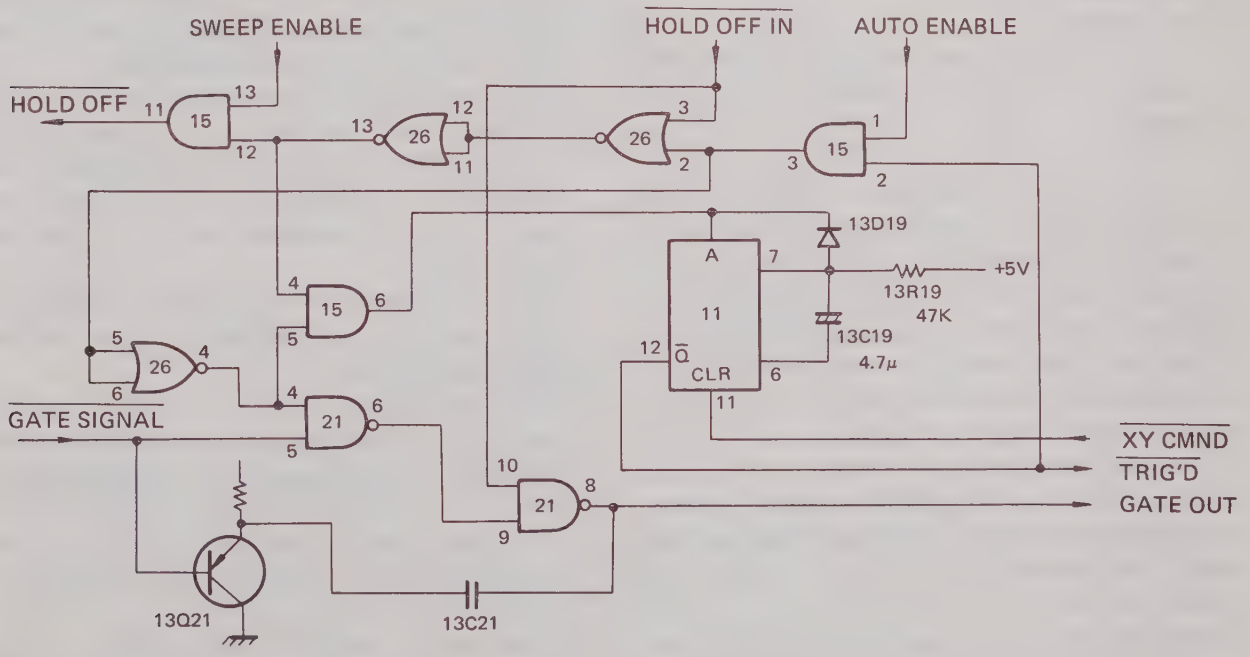
The sweep control circuits 13IC11, 13IC15, 13IC21, and 13IC26 are used to output the gate signal according to the sweep mode of AUTO, NORM, or SINGLE and guide the gate signal to the sweep generator and A GATE OUT terminal. The sweep control circuit outputs $\overline{\text{TRIG'D}}$ at the trigger condition, puts out the LED of TRIG'D when X-Y operation starts, and outputs HOLD OFF signal to the jitter free flip-flop circuit.

The 13Q21 and 13C21 speed up the trigger pulse signal by applying it to the sweep generator and the A GATE OUT.

The 13R19 47 kΩ and 13C19 4.7 μF are used to define the time constant (about 30 ms) when the sweep mode is set to AUTO. The 13IC11 is a monostable multivibrator. It becomes self-sweep state when the sweep mode is set to AUTO and no signal is available. The moment X-Y operation occurs, the pin 11 (CLR) of 13IC11 makes the pin 12 (Q) of 13IC11 Lo and turns LED off. The pin 13 (SWEEP ENABLE) of 13IC15, when Lo, makes $\overline{\text{HOLD OFF}}$ Lo and keeps the sweep stop state. $\overline{\text{HOLD OFF IN}}$ signal that is input to the pin 10 of 13IC31 is to speed up the sweep end pulse.

When AUTO ENABLE is Lo, that is, when the sweep mode is NORM, the pin 4 of 13IC26 becomes Hi; at this time, the sweep starts with $\overline{\text{GATE SIGNAL}}$ being Lo and the sweep stops with $\overline{\text{GATE SINGAL}}$ being Hi. When AUTO ENABLE is Hi, that is, when the sweep mode is AUTO, pin 2 ($\overline{\text{TRIG'D}}$) of 13IC15 becomes Lo at the trigger sweep state; and the operation is the same as that at the mode of NORM. When the trigger pulse signal (with $\overline{\text{GATE SIGNAL}}$ Hi) is applied for about 30 ms or more,

Figure 4-1-12. A-sweep control circuit



the output of the pin 12 ($\overline{Q}$) of 13IC11 becomes Hi, making the pin 9 of 13IC21 Hi, and self-sweep is caused by $\overline{\text{HOLD OFF IN}}$ signal applied to the pin 10 of 13IC21. $\overline{\text{HOLD OFF IN}}$ signal applied to the pin 14 of 12IC15 and 13D19 wait trigger pulse signal for about 30 ms after HOLD OFF signal is released (while waiting for trigger pulse signal), then self sweep starts.

The sweep generator uses the sawtooth-wave for sweeping horizontal axis (time axis) and thus comprises the sawtooth-wave generator. The sawtooth-wave generator can be set, by selecting the sweep mode, to the three kinds of AUTO, NORMAL TRIGGER, and SINGLE SWEEP operations, and depending on the operation, the following signals are generated:

- Sawtooth-wave

  This is guided to the horizontal amplifier, amplified, and applied to the horizontal deflection plate of CRT. Also it is guided to the B-sawtooth-wave generator to generate delayed pulse.
- Unblanking signal

  This brightens the traces and erase the refrace lines. This signal is guided to the Z-axis amplifier, amplified, and applied to the CRT.
- Gate pulse signal

  +GATE that is positive during saw-tooth wave rising is generated, amplified and guided to the A GATE OUT terminal.
- $\overline{\text{A ENDS B}}$

  This is a Lo level pulse signal to end B-sweep at the moment the A-sweep ends. The signal is guided via the horizontal axis control circuit to the B-sweep generator.

When the sweep mode is set to AUTO and the trigger pulse signal is not applied to the sawtooth-wave generator, or the trigger level exceeding the trigger range is set, the self-sweep occurs automatically. When the trigger pulse signal is applied, the trigger state appears.

When the sweep mode is set to NORM and the trigger pulse signal is not applied to the sawtooth-wave generator or the trigger level exceeding the trigger range is set, the sweep stops. When the trigger pulse signal is applied, the trigger state appears.

When the sweep mode is set to SINGLE/RESET, the sweep stops (and waits for trigger pulse signal). When the trigger pulse signal is applied, sweep occurs once. Thereafter, a single sweep takes place where the sweep is not caused by applying trigger pulse signal. While waiting for the trigger pulse signal, LED of READY is lit.

The TIME/DIV switches determine the sweep speed. It is selected by A TIME/DIV. The sawtooth-wave generator consists of the capacitor and the resistor of the TIME/DIV switch, and 15Q21 and 15Q23 circuits.

When the disconnect amplifier 13Q31 is turned off, the timing capacitor is charged by the current of the constant current circuits 15Q21 and 15Q23. The capacitor terminal voltage is applied to the sweep control circuit via the buffer amplifier 13Q41 and the hold-off generator.

When the saw-tooth wave level reaches the given output value, the sweep control circuit turns the disconnect amplifier ON. This is the state to stop sweep. This causes the timing capacitor to discharge, and the saw-tooth wave level returns to the start level.

With the sweep start comparators 13Q35 and 13Q37, the output from the buffer amplifiers 13Q41, 13Q43 and 13Q55 is fed back to the disconnect amplifier so that the capacitor is discharged to a given level (start level) and kept at this level. In this manner, to end the sweep and to start a new sweep, a given time is necessary. This time is given by the hold-off generator. After a given time has elapsed, the output from the hold-off generator causes the sweep control circuit to wait for the trigger pulse signal.

The jitter free circuit receives the output indicating that the sweep control circuit is waiting for, and guides the jitter-free sweep start signal to the sweep control circuit. When the sweep control circuit receives this sweep start signal, it turns the disconnect amplifier off. This starts the next sweep.

The sweep control circuit also outputs unblanking signal, which is guided to the Z-axis amplifier through the horizontal axis control circuit.

The gate-out signal is branched from the output of the sweep control circuit, guided to the gate signal amplifier 13Q25 and amplified, then guided to the A GATE OUT terminal.

The output from the sweep generator is guided to the horizontal-axis amplifier through the horizontal axis control circuit.

The hold-off generator 13IC71, 13Q71, 13IC75, 13IC81, 13IC21, and 13IC26 receive the saw-tooth wave signal stated before, and generate hold-off signal (sweep inhibit signal), and guide it to the sweep control circuit.

The length of hold-off signal is determined by the capacitor and resistor of the hold-off circuit.

The length of hold-off signal can be varied in a range of about 1 : 10 by changing the capacitor attached to the timing switch and by the variable resistor. The longest hold-off signal (from 0.5 s/div to 5 ms/div) is generated by selecting 13IC75 and 13C75. The 13Q71 is the switch to discharge the capacitor 13C72 of the hold-off circuit. The 13IC81 forms the control circuit to start the 13Q71 and two comparators to determine the length of discharge. The circuits of pins 1, 2, and 3 of 13IC21 generate, by means of $\overline{\text{A SWEEP ENDS}}$ signal or $\overline{\text{B ENDS A}}$ signal, the SWEEP ENDS signal. Also, these circuits of pins 1, 2, and 3 of 13IC21, together with the circuits of pins of 11, 12, and 13 of 13IC21 and 13IC26 constitutes the speed up circuit of the signal.

At single sweep, SWEEP ENABLE signal is output from the single sweep control circuits 13IC15 and 13IC91, according to the RESET signal. The circuits of pins from 9 to 13 of 13IC91 comprise the RESET switch chattering preventive circuit. The circuits of pins 1 through 5 of 13IC91 at the other side perform the following operations:

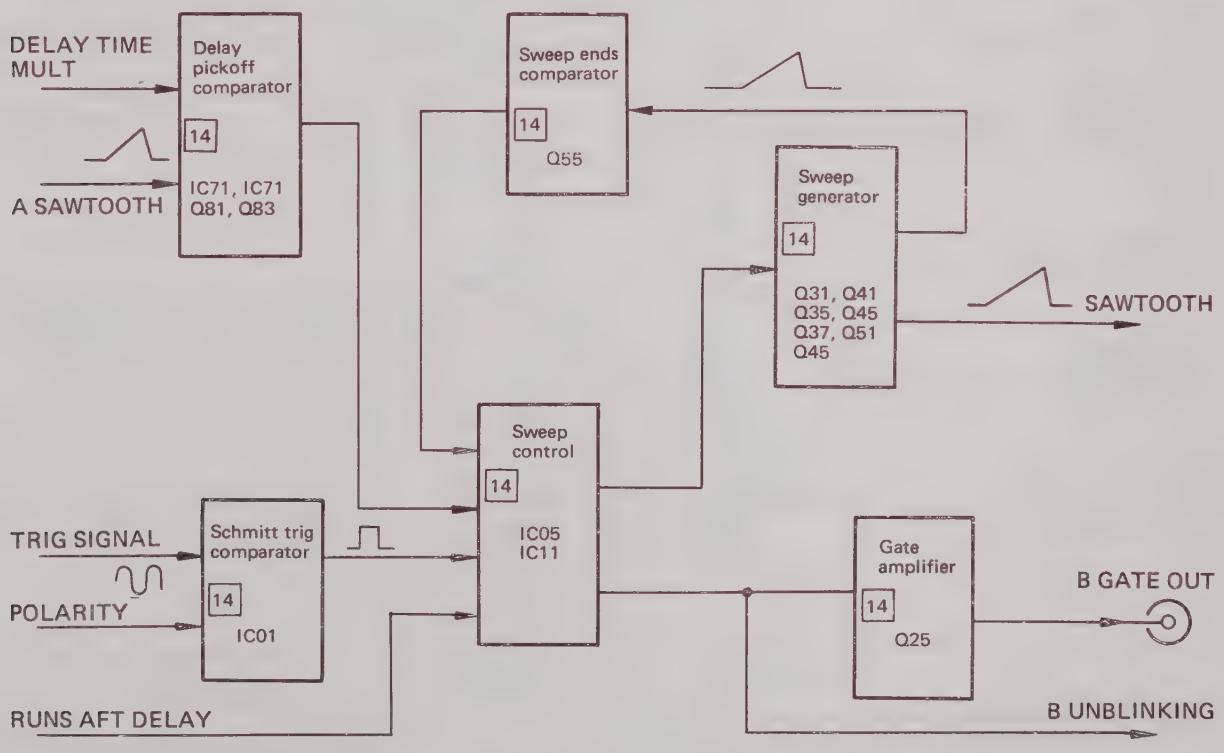
When the sweep MODE is AUTO/NORM
13IC71 pin-4 ($\overline{\text{PR}}$, SINGLE ENABLE): Lo
13IC91 pin-5 (Q,SWEEP ENABLE): Hi
When the sweep MODE is SINGLE
13IC91 pin-4: Hi
13IC91 pin-5: Lo (Hi according to RESET)
13IC15 forms the buffer amplifier.

b. B-sweep generator [14]

The B-sweep generator is as shown in Figure 4-1-13. Here, the same circuits as in the case of A-sweep generator are not described and only the circuits specific to the B-sweep generator will be described.

The B-sweep generator operates when the HORIZ DISPLAY is set to A INTEN, ALT, and B (DLY'D). A given time after the A-sweep generator starts sweep (delay

Figure 4-1-13. Block diagram of B-sweep generator



time), the B-sweep generator starts sweep. The delay time is determined by the set values of A TIME/DIV and DELAY TIME MULT.

If the SOURCE of B is set to the trigger delay (CH1, CH4), then after the delay time, the DELAY PICKOFF pulse signal is applied to the sweep control circuit and B-sweep is started by the trigger pulse signal. If it is set to the continuous delay (RUNS AFTER DELAY), then after the delay time, the DELAY PICKOFF pulse signal is applied to the sweep control circuit, then immediately B-sweep starts.

The B-sweep generator, by these operation, generates the following signal.

- Sawtooth-wave

  This is guided to the horizontal amplifier and amplified, then applied to the horizontal deflection plate of CRT.
- Unblanking signal

  This brightens the traces and puts out the retrace traces. This signal is guided to the Z-axis amplifier and amplified, then applied to the CRT.
- Gate pulse signal

  +GATE that is positive during sawtooth-wave rising is generated, amplified and guided to the B GATE OUT terminal.

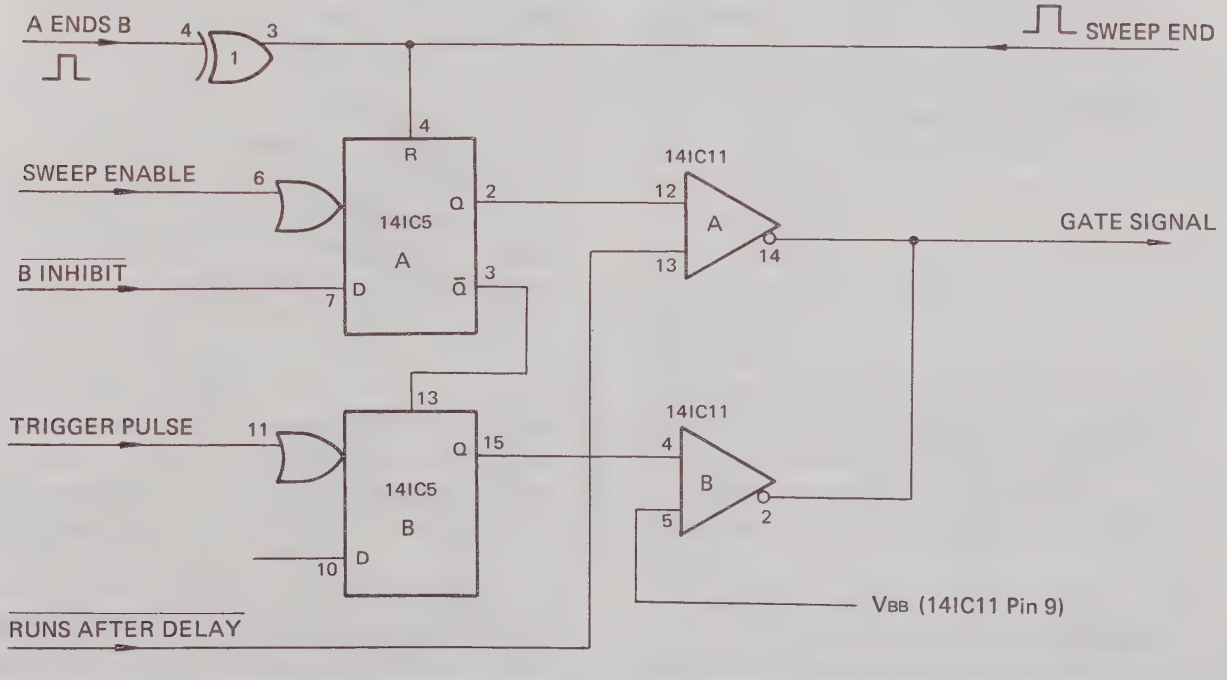
The B-sweep generator operates nearly the same as in the case of the A-sweep generator stated before. Thus, the circuits specific to the B-sweep generator are the delay pickoff comparator circuit and the sweep control circuit.

The delay pickoff comparator circuits 14IC71, 14IC91, 14Q81, and 14Q83 have the following functions:

- At a given time after the start of A-sweep (delay time), the delay pickoff pulse signal is guided to the sweep control circuit.
- If A-sweep ends during B-sweep, the B-sweep is ended.

Thus, the saw-tooth wave signal of A-sweep is guided via 14IC71 to 14IC91. The DELAY TIME MULT is used to determine the voltage (comparison voltage) defining the delay time after the start of A-sweep. When the sawtooth wave of A has reached the set voltage, the delay pickoff pulse signal is generated, applied to the sweep control circuit, and B-sweep is started.

Figure 4-1-14. B-sweep control circuit



When HORIZ DISPLAY is set to A, the B-sweep generator does not perform sweep.

The sweep control circuits 14IC5 and 14IC11 output the gate signal according to the setting of RUNS AFTER DELAY and TRIGGER'D DELAY (CH1, CH2, CH4) of B-source. This gate signal is guided to the sweep generator and the B-GATE OUT terminal. The sweep control circuit, by means of B-INHIBIT signal, inhibits sweep and, by means of A ENDS B, ends the sweep.

The B sweep control circuit is as shown in Figure 4-1-14. The A of 14IC5, by means of SWEEP ENABLE signal from the delay pickoff comparator, sets the B of 14IC5 to the state of waiting the trigger pulse signal, and applies the gate signal to the A of 14IC11. At B INHIBIT Lo, the pin 7 of 14IC5 is prohibited to make sweep even if SWEEP ENABLE signal is applied to A of 14IC5.

When the B of 14IC5 is RUNS AFTER DELAY, the state is (see Figure 4-1-15):

$\overline{\text{RUNS AFT DLY}}$: Lo

If the trigger pulse is input, TRIG'D GATE signal (pin 15 of 14IC5) is not output.

When the B of 14IC5 is TRIGGER' DELAY, the state is:

$\overline{\text{RUNS AFT DLY}}$: Hi

According to the input of the trigger pulse, TRIGGER'D GATE signal is output.

When the A and B of 14IC11 are RUNG AFTER DELAY, the state is (see Figure 4-1-15):

$\overline{\text{RUNS AFT DLY}}$: Lo

The pin 13 of 14IC11 A enable level (nearly equal to the pin 11 of V_{BB} 14IC11)

The pin 14 of 14IC11 A gate signal is output.

When the A and B of 14IC11 are TRIGGER'D DELAY, the state is:

$\overline{\text{RUNS AFT DLY}}$: Hi

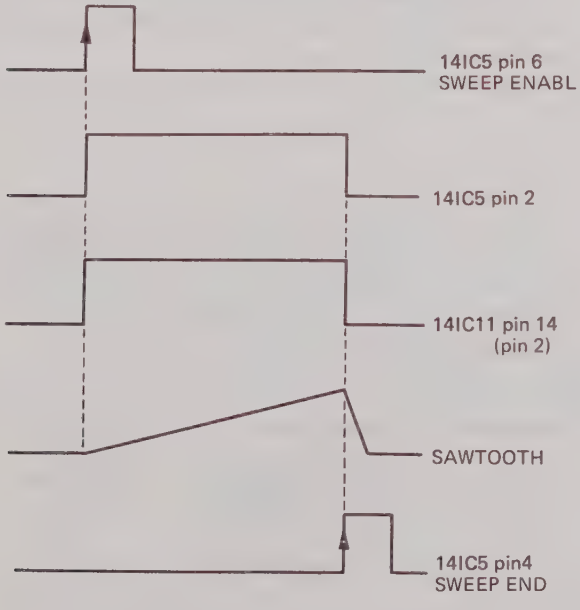
The pin 13 of 14IC11 A: Hi

The pin 14 of 14IC11 A: Lo

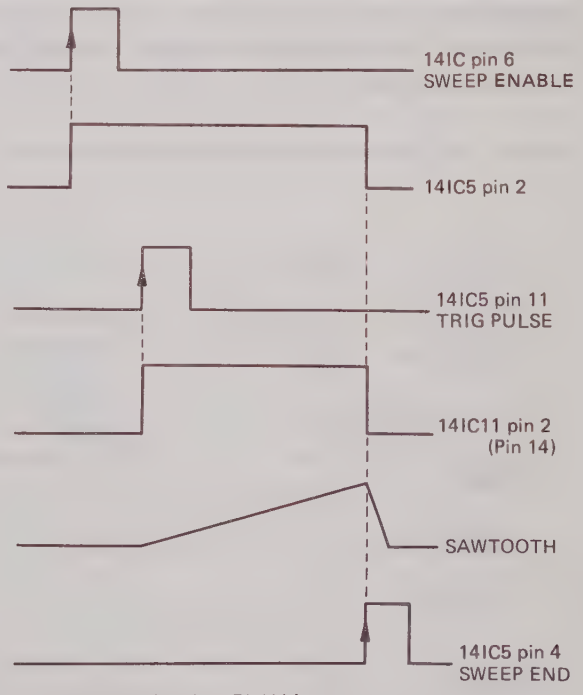
The pin 2 of 14IC11 B: TRIGGER'D GATE signal is output.

The A of 14IC5 is reset by A ENDS B signal or SWEEP END signal, and the gate signal is closed.

Figure 4-1-15. Timing chart



When RUNS AFTER DELAY is set
($\overline{\text{RUNS AFTER DELAY}}$: Lo)



When TRIGGER'D DELAY is set

4-1-5 Horizontal-axis Amplifier 18

The horizontal-axis amplifier is as shown in Figure 4-1-16. This amplifier amplifies one of the following signals to a sufficient amplitude to deflect CRT electron beam in horizontal direction.

- A- or B-sweep sawtooth-wave signal
- In X-Y scope operation, the signal applied to the input of CH1

The input-common emitter amplifiers 18Q11 and 18Q12 circuits are used to branch the amplified output signal and to guide it to the negative feedback circuit that returns the signal to the base. The negative feedback is used to improve and stablize the frequency characteristics.

The input signal to these circuits is converted to a current and applied to the base of 18Q11. This changes the currents passing through the feedback resistors 18R15 and 18R21, and the changed current is output as the voltage amplitude.

The POSITION and FINE are variable resitors to change the input current of the base of 18Q12 and to adjust the horizontal position of electron beam on CRT.

The gain setting and limiting amplifiers 18Q13 and 18Q14 have the following functions:

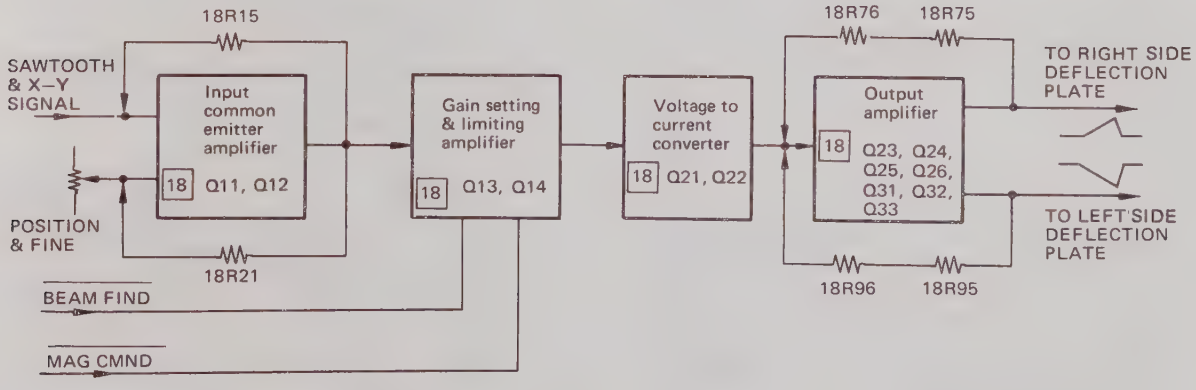
- By means of the differential amplifier consisting of 18Q13 and 18Q14, the signal applied to the base of 18Q13 is output as two signals having opposite poralities from the collectors of 18Q13 and 18Q14.
- In the magnifier of PULL x 10 MAG, the gain is selected by the emitter resistors of 18Q13 and 18Q14 that are switched by the reed relay 18RL31.
- The constant current circuit consisting of 18Q15 and 18Q16, and the load resistances of 18R24 and 18R25 of 18Q13 and 18Q14 are used to limit the amplitude, so that the last-stage amplifier is not saturated when the magnifier is set to PULL x 10 MAG. And the above function also includes that, when BEAM FIND is set, the current of the constant current circuit formed by 18Q15 and 18Q16 is reduced so that electron beam is guided onto the screen.

By means of the voltage-to-current converter 18Q21 and 18Q22, the signal voltage applied to the base of the transistor is converted to the current and guided to the output amplifiers.

The output amplifiers 18Q23, 18Q24, 18Q25, 18Q26, 18Q31, 18Q32, and 18Q33 are used to amplify the signal applied from the former stage to a sufficient amplitude to deflect CRT electron beam in the horizontal direction.

Thus, the signal amplified by 18Q23, 18Q24, 18Q25 and 18Q26 is guided to the right-side deflection plate; the signal amplified by 18Q31, 18Q32 and 18Q33 is guided to the left-side deflection plate.

Figure 4-1-16. Block diagram of horizontal-axis amplifier



The 18Q23, 18Q24 and 18Q31 are the emitter followers that operate as the buffers. They drive the output transistors with low impedance. Particularly when 18Q25 output voltage rises at a high-speed sweep, the 18Q23 drives 18Q25 to speed up the rising of output signal.

The 18R75, 18R76, 18R95 and 18R96 are feedback resistors, They lower the output impedance and improve the frequency characterisitcs and stability.

4-1-6 Z-axis Amplifier [19]

The Z-axis amplifier is as shown in Figure 4-1-17 and has the following functions:

- Amplifies unblacking signal that brightens trace lines and blank out the retrace lines during A or B sweep.
- Amplifies chok blanking signal that erasses transient phenomena appearing when the vertical mode is set to CHOP.
- Amplifies external intensity modulation signal applied to the Z-axis input terminal.
- Adjust the brightness by means of INTEN and B INTEN.
- By means of ENHANCE, the brightness is further increased when A-sweep time is in a range of 2 ms/div to 2 ns/div.
- Performs AUTO FOCUS function to adjust the focus voltage in association with INTEN operation.

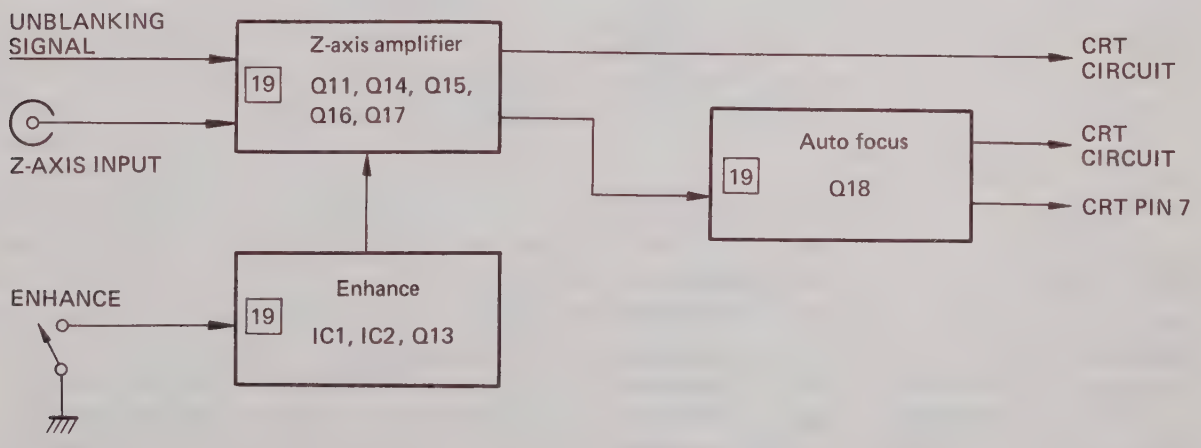
The blanking signal is guided to the emitter of 19Q11. The 19Q11 is a base-ground amplifier having a low input impedance. The output signal of 19Q11 is amplified by the feedback amplifier consisting of 19Q14, 19Q16, 19Q15 and 19Q17 and feedback resistors 19R55, 19R56 and 19R57. The 19D31 and 19D32 are to prevent 19Q17 from saturation.

The signal applied from the z-axis input is converted by 19R11 and 19R12 to a current. This current is used to change the output level of the above to the feedback amplifier and thus change the intensity of CRT.

The enhance circuit consists of 19Q13, 19IC1 and 19IC2. By pushing ENHANCE switch, ENHANCE ENABLE signal is output from the collector of 19Q12 and guided to the CRT circuit via he feedback amplifier.

The auto focus circuit 19Q18 converts the voltage set by 19R62 AUTO FOCUS to a current. The current is amplified with feedback amplifier of 19D61 and guided to the pin-7 focus electrode of CRT. The current is partly applied to 20D5 and 20D6 and guided to the pin-5 and pin-11 focus electodes of CRT so that the best focus condition is maintained independent of INTEN if changed.

Figure 4-1-17. Block diagram of Z-axis amplifier



4-1-7 CRT Circuit [20]

The CRT circuit, by applying high-voltage bias to each electrode, generates high-voltage supply to enable electron beam to draw high-speed, clear raster on the screen. It also guides the intensity modulation signal and unblanking signal to the CRT.

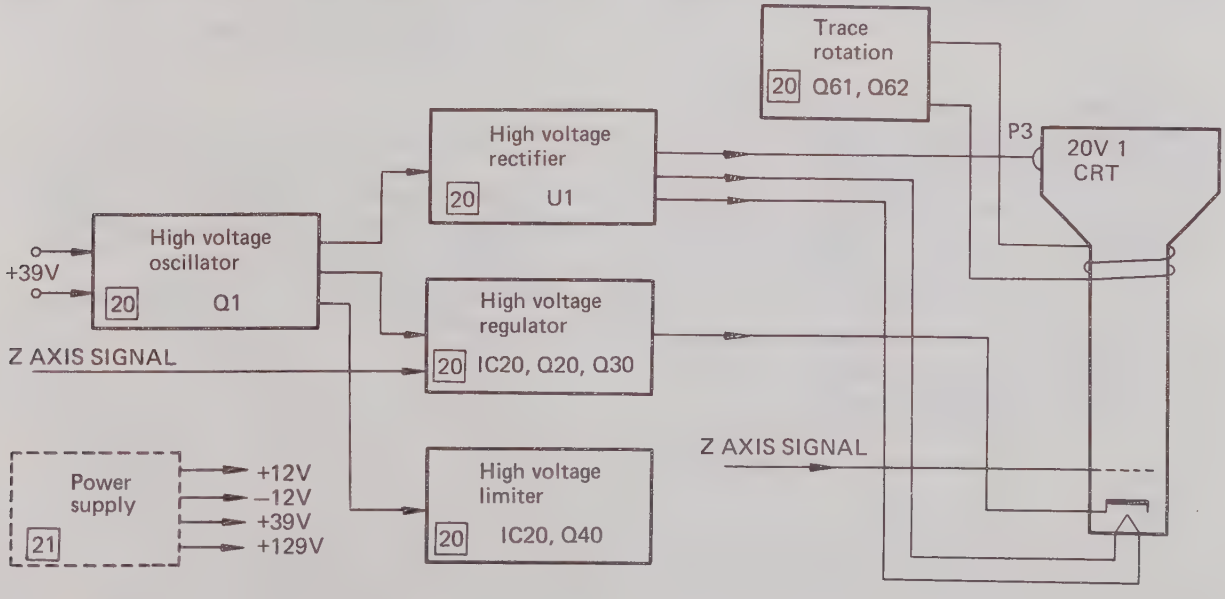
The CRT circuit is as shown in Figure 4-1-18. The CRT circuit consists of the DC-DC converter circuit to supply the bias voltages of from about +17.55 kV to about −2.45 kV, and the limiter circuit to automatically lower the high-voltages if it becomes too high.

The high-voltage oscillator circuit consists of 20Q1, 20D1, 20C1, 20R1 and the primary winding of 20T1. The 20Q1 is the oscillation transformer to which the positive feedback is applied from the collector winding of 20T1 through the base winding, so that the 20Q1 makes repeated oscillation of about 30 kHz and generates high-voltage at the secondary winding. The 20C24 and 20R22 supply the base current of 20Q1. The 20C23, 20Q20 and 20Q30 circuits operate at the start of oscillation, and is turned off during oscillation. The 20D1 and 20R1 are the protection circuit to prevent the voltage from exceeding the withstand reverse voltage between the base and emitter of 20Q1.

The high voltage regulator circuit 20IC20 (1/2) makes such control that the high voltage generated by the high voltage oscillator is regulated, independent of variations in the brightness and the primary voltage, so that the CRT cathod voltage is −2.45 kV and CRT deflection factor is always kept constant. The regulator circuit consists of the error amplifier formed by 20IC20 (1/2), 20R21, 20R16, and 20R17, and the error detection circuit of 20R12, 20R13, 20R14, and 20R18 having the reference voltage of +39 V. In this circuit, 20IC20 (1/2) functions to maintain the voltage across 20R12 at −2.45 kV, and the output of 20IC20 controls, via 20R22, the base current of 20Q1 and thus the oscillation intensity.

The high-voltage limiter circuit of 20IC20 (1/2) and 20Q40 functions as follows. If 20Q1 oscillation amplitude rises abnormally by any reason, then the 3rd anode P3 of CRT may have high-voltage and X-rays may leak from CRT. Thus, if the CRT cathode voltage reaches −2.6 kV to −3.0 kV, the limiter circuit functions to make high-voltage oscillation intermittent. The high-voltage limiter circuit consists of the Schmidt trigger circuit of 20IC20 (1/2), 20D34, 20R34, 20R35, 20R45 and 20R46, the detection circuit of 20R36, 20R37 and 20R38, and the control circuit of 20R40, 20R32, 20R33 and 20D32.

Figure 4-1-18. Block diagram of CRT circuit



When the CRT cathode voltage exceeds −2.6 kV, the voltage at pin 6 of 20IC20 (1/2) drops, the Schmidt trigger circuit inverts, and the voltage at pin 7 of 20IC20 inverts. This makes 20Q40 ON and draws the base current of 20Q1 through 20D32, and as a result, the oscillation stops and the CRT cathod voltage is controlled below −2.6 kV. When the oscillation has stopped, the voltage across the 20C37 discharges through 20R37. This inverts the Shmitt circuit, and the high-voltage oscillation starts again. If, however, the CRT cathode voltage exceeds −2.6 kV again, the above-mentioned operation repeats itself, and thus makes the high-voltage oscillation intermittent. As a result, the CRT screen brightens intermittently.

The high-voltage rectifier includes the 6-times rectification circuit that supplies +17.55 kV to the 3rd anode P-3 of CRT, the half-wave rectification circuit that supplies cathode voltage and 1st grid voltage, the focus electrode circuit of pin 5, and the ASTIG electrode circuit of pin 11.

The trace rotation consists of 20Q61, 20Q62, 20R62, 20R63, and 20L61. The rotaion coil is installed on the CRT neck, current passes through the coil, and the generated magnetic flux changes the angle of CRT electron beam. The current is controlled by the trace rotation 20R62. The 20Q61 and 20Q62 convert the current passing through 20R62 to a small current.

4-1-8 Power Supply 21

The low-voltage supply circuit is as shown in figure 4-1-19. Five stablized power supplies are provided to operate stably each circuit of this equipment. The stabilized power supply circuits provide stably the low ripple output voltage not affected by the load variation, and, if the outputs are grounded, they are not damaged by the protective circuit.

In the power input circuit, the supplied power is guided via fuses to the power selection plug. Depending on the setup of the power selection plug, two windings of the primary side of the power transformer 21T1 are changed to series or parallel connections, so that 100 V, 115 V, 220 V, 230 V, or 240 V can be selected.

The −12 V supply circuit serves as the reference voltage for other stabilized power supplies (except for +5 V). The output voltage of the power transformer undergoes full-wave rectification by the rectifier 21D60, and becomes dc by being smoothed by the electrolytic capacitors 21C61 and 21C62. The plus voltage side of the smoothed output voltage is guided to the series regulator circuit that is controlled by the +12 V supply described later; the minus voltage side is guided to the series regulator of 21Q31, 21Q32 and 21Q33 that is controlled by the −12 V supply. The series regulator is controlled by the error amplifier 21IC12 (1/4). In the error amplifier, the Zener voltage of about −5.6 V of the Zener diode 21D72 is guided, as the reference voltage, to the pin 12 of 21IC12. The set voltage on the variable resistor 21R77 is guided to pin 13. With this set voltage, the base current of the series regulator 21Q32 is controlled by the output from the pin 14 of 21IC12. The 21Q3 is the low-current protection circuit.

In the +5 V power supply circuit 21IC30, the output from the power transformer is applied to the rectifier 21D30, undergoes full-wave rectification, smoothed by the electrolytic capacitor 21C32, and guided to the series regulator 21IC30. The 21IC30 functions, as in the case of the −12 V supply circuit stated before, and outputs the stabilized +5V voltage.

The +12 V, +39 V and +129 V power supply circuits use the stabilized −12 V voltage as the reference voltage, and respectively output the stabilized voltages of +12 V, +39 V and +129 V. The circuit configurations and operations are nearly equal to those of the −12 V power supply circuit.

The 9 V output voltage of the power transformer is lowered by the scale 21R34 to about 6.3 V and supplied to the scale lamp to light the CRT scale. The lamp brightness is changed by controlling the current passing through the lamp by means of the variable resistor SCALE 21R34.

4-1-9 Calibrator 21

The calibrator circuit is as shown in Figure 4-1-20. The calibrator, by means of the +12 V supply, outputs square wave 0.6 V voltage and 10 mA current. The output voltage and current are used to calibrate the vertical deflection sensitivity and to adjust the probe phase.

The switching circuit of 21Q11 and 21Q21 is used to apply +12 V to the emitter of 21Q11 and supply the current to 21Q11, 21R14, 21R15 and 21R16 circuits. At this

Figure 4-1-19. Block diagram of power supply

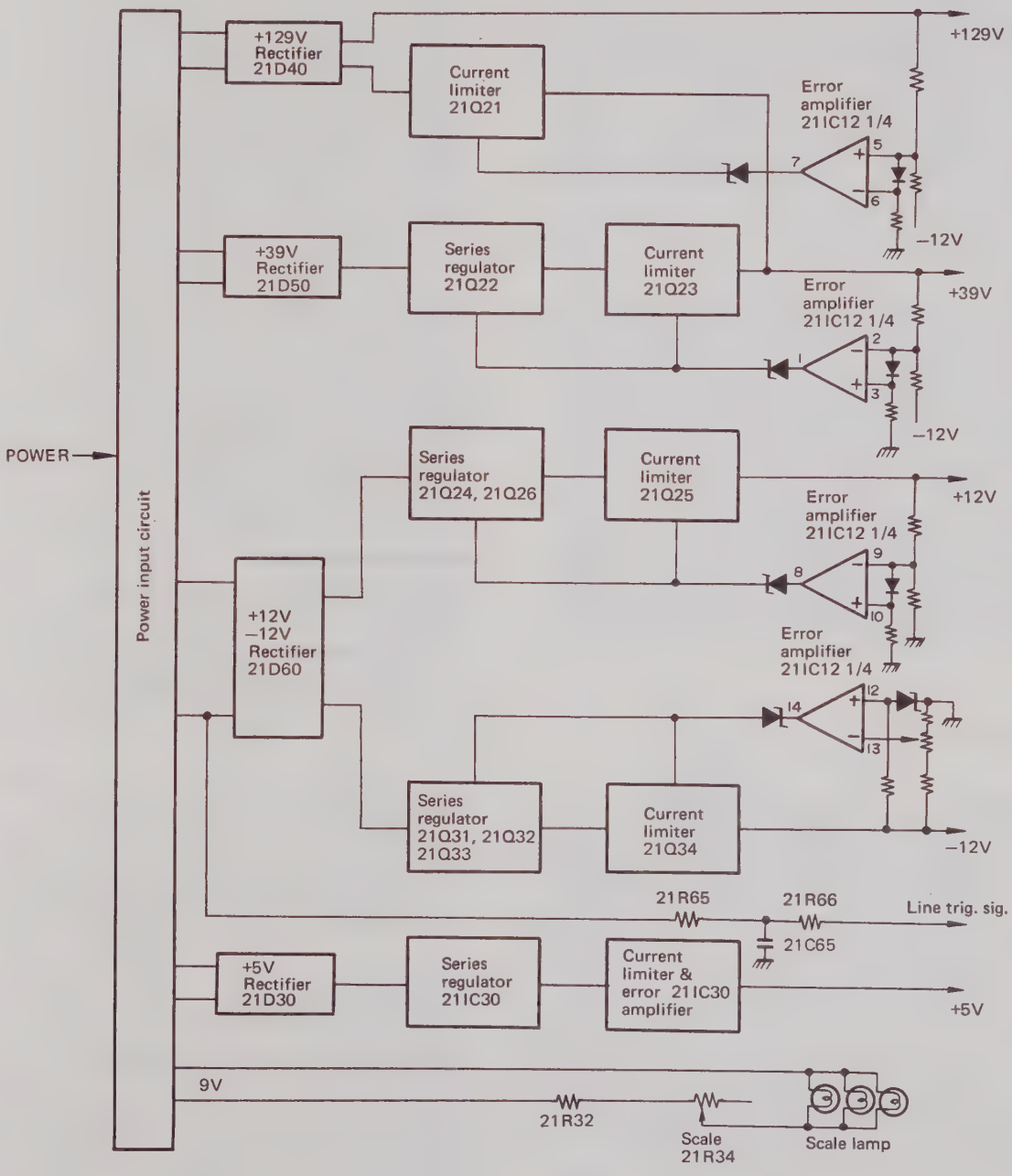
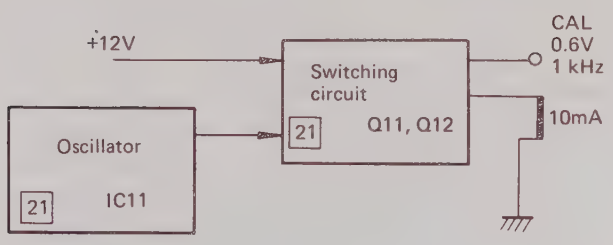


Figure 4-1-20. Block diagram of Calibrator



time, the voltage across 21R16 is applied to the CAL terminal. The current passes through the 10mA-loop terminal.

The 21Q11 is driven by the current passing through it which is made ON/OFF by operating 21Q12. The current level is controlled by resistor 21R14.

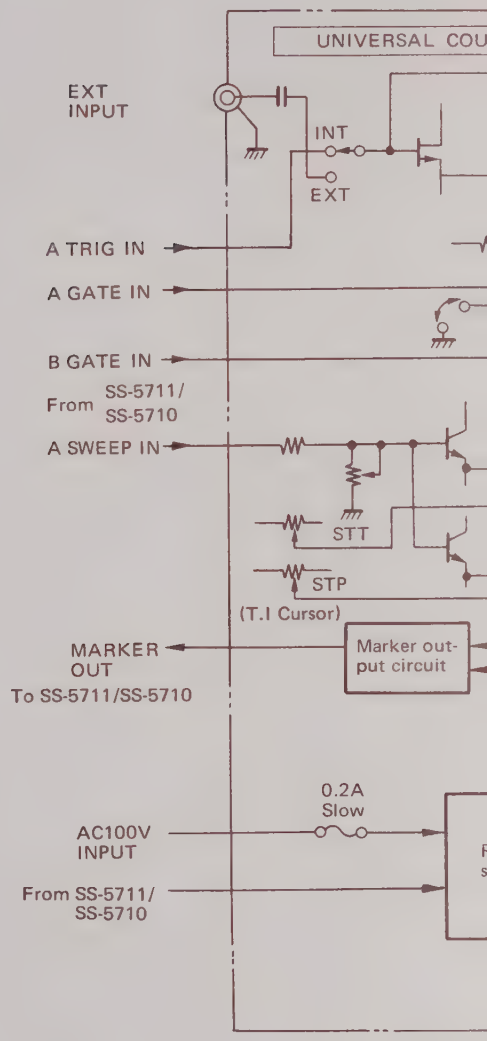
The oscillator 21IC11 consists of 21IC11, 21IC21, 21R26 and 21R27. The 21R22 makes positive feedback for level up. The repetition frequency of the oscillator is determined by setting the frequency of 21R26. The output signal is guided from the pin 1 of 21IC11 to the base of 21Q12 and switches ON/OFF operation of 21Q21.

4-2 UNIVERSAL COUNTER UNIT

4-2-1 General Description

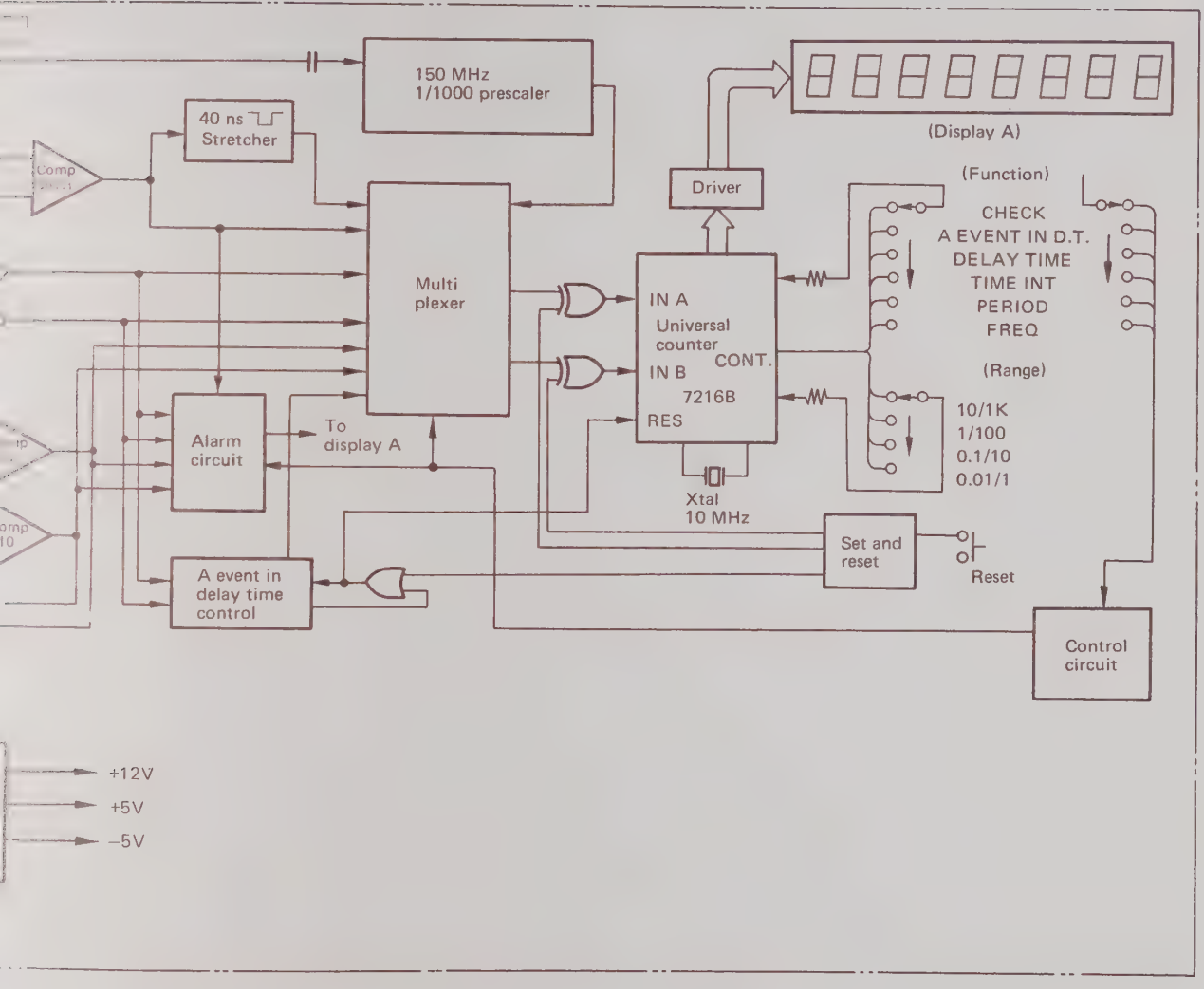
The universal counter unit has the circuit configuration as shown in Figure 4-2-1. The universal counter unit, by combining with the oscilloscope unit, indicates the signal frequency, period, time interval, delay time, and A EVENT IN DELAY TIME being observed on the oscilloscope. Also the signal can be directly input to the external signal input terminal of the universal counter, and its frequency and period can be obtained. All values are converted to digital signals and indicated on the light emitting diodes (red).

Figure 4-2-1. Block diagram of universal coun



4-2-2 1/1000 PRESCALER [1]

The 1/1000 prescaler divides the input signal into 1/1000 and outputs the signals to measure frequency and period. When the INT-EXT switch 1S2 is set to INT, the A-sync pulse signal from the oscilloscope unit is applied to the base of 1Q001 and the pin 3 of 1Q003; when set to EXT, the signal applied to the EXT input terminal is similarly applied to the base of 1Q001 and the pin 3 of 1Q003. At EXT connection, signal coupling will become an AC coupling by 1C054.


150 MHz
1/1000 prescaler
40 ns
Stretcher
Comp
Multi
plexer
Driver
(Display A)
(Function)
CHECK
A EVENT IN D.T.
DELAY TIME
TIME INT
PERIOD
FREQ
IN A
Universal
counter
IN B
CONT.
7216B
RES
(Range)
10/1K
1/100
0.1/10
0.01/1
Xtal
10 MHz
Alarm
circuit
To
display A
Set and
reset
Reset
A event in
delay time
control
Control
circuit
+12V
+5V
–5V

When a signal is applied to the 1/1000 frequency divider, all repetitive periods are divided into 1/1000, and guided to the control circuit. The input signal is divided in two steps; 1/100 by 1IC005, then 1/10 by 1IC006.

Meanwhile, the signal applied to the shaping circuit is guided through the comparator 1Q003 to pin 3 of 1IC007. In 1IC007, all input signal waveform is shaped into pulse signal form and is output from the pin 7. The shaped pulse signal is branched and guided via 1IC23 directly to the control circuit. The output signal from the shaping circuit is guided to teh stretcher circuit 1IC13, where it is further shaped into the signal of constant pulse width (40 ns) and guided to the control circuit.

4-2-3 Time Interval Control [2]

The time interval control circuit is as shown in Figure 4-2-4.

The time interval control circuit receives the A-B gate pulse and A-sweep sawtooth-wave signals and outputs the signals to measure delay time, A EVENT IN DELAY TIME time interval, and others. The A and B pulse signals from the oscilloscope units are input to the pulse polarity switch 2IC009. This equipment is designed to operate with the input pulse signal of the positive polarity, and so, if the input pulse has the negative polarity, the polarity must be changed. The output signal from the polarity switch is guided to the control circuit and is used as the start and stop signals to measure delay time, as shown in Figure 4-2-3. The output from the polarity switch is also branched and applied to the A EVENT IN DELAY TIME circuit 2IC010, 2IC011, 2IC12, 2IC008, and 2IC016. The pulse to measure the A EVENT IN DELAY TIME is output as shown in Figure 4-2-5. This circuit measures the A EVENT IN DELAY TIME once, then a given time later (hold-off time), repeats the measurement by the reset pulse signal. The hold-off time is determined by 2C024 and 2R030.

Figure 4-2-2. Block diagram of 1/1000 prescaler

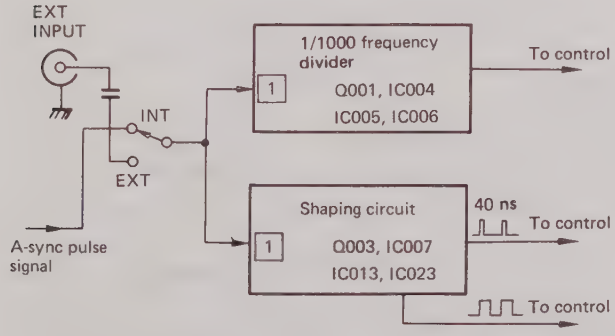


Figure 4-2-3. Delay time measurement

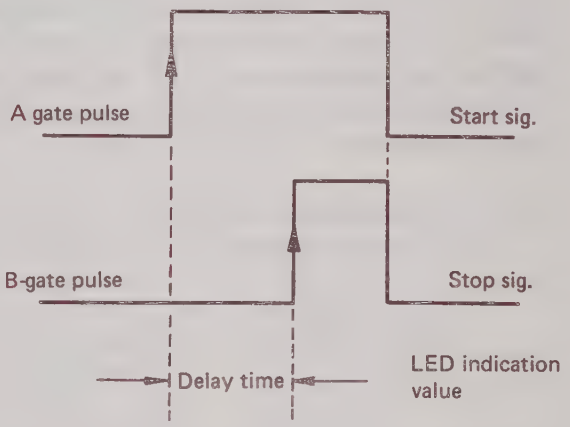
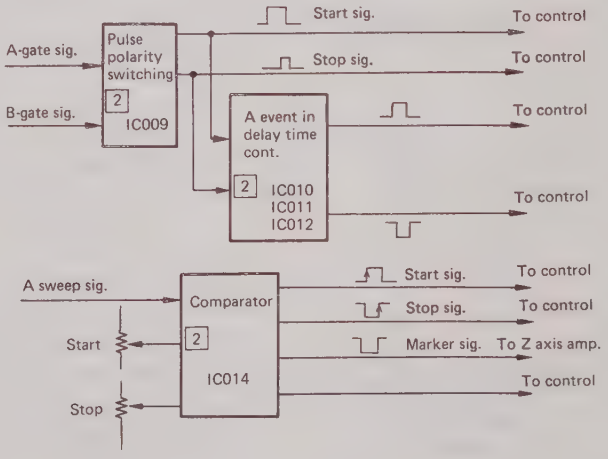


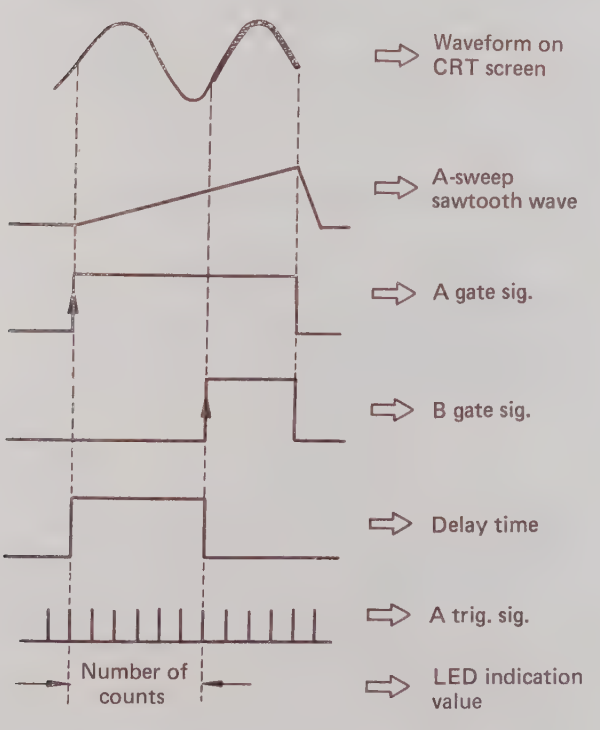
Figure 4-2-4. Block diagram of time interval control



The comparator 2IC014 outputs the pulse signal to measure time intervals. As Figure 4-2-6 shows, the A-sweep sawtooth-wave is guided to the comparator, and the start point E1 of the waveform on the CRT screen to be measured is determined by the comparator 2IC014 and the variable resistor 2R048 to start the time internal cursor. Also the stop point E2 is set by the comparator 2IC015 and the variable resistor 2R049 to stop the time interval cursor.

The time interval between the start and stop points is converted to the negative—polarity marker pulse signal and output from the pin 8 of 2IC016. The marker pulse signal is guided to the Z-axis amplifier of the oscilloscope and amplified, then applied to the CRT circuit, where the screen waveform under observation undergoes maker-type intensity modulation.

Figure 4-2-5. Measurement of A EVENT IN DELAY TIME



4-2-4 Control Circuit 3 , 5

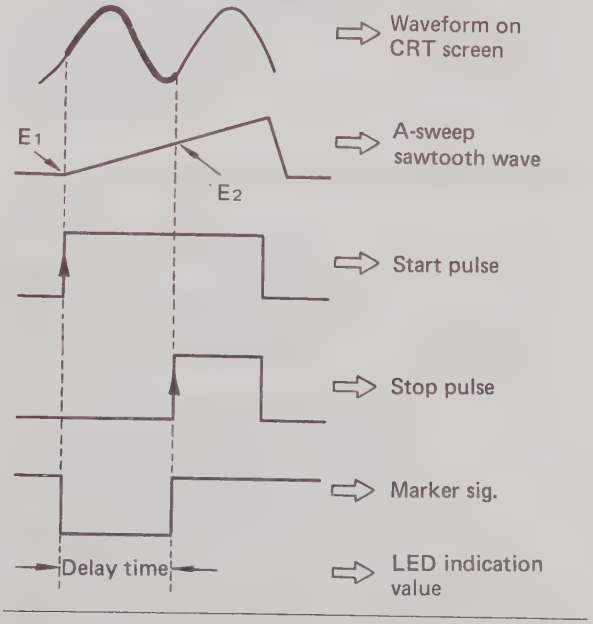
The control circuit is as shown in Figure 4-2-7. This circuit uses the function switch to select the signal to measure the frequency, period, time interval, A EVENT IN DELAY TIME, delay time, and others stated before. The selected signal is counted with ICs and the crystal oscillator and is indicated on LED.

The signal selectors 3IC017 and 3IC018 select, by setup of the function switch, various signals guided to the control circuit. The selected signal is handled by the counters 3IC019, 3FB001 and 3X001 and its trigger pulses of frequency, period, time interval, A EVENT IN DELAY TIME, delay time, and others are counted.

In the counter, its crystal oscillator 3X001 generates the reference frequency of 10 MHz and the gate pulse is formed. The counter counts the number of the input trigger pulses that pass during gate pulse being open, and indicates the result on LED.

The range switch is set the proper range to measure the frequency and period, depending on the signal to be measured and the digits required for the measurement.

Figure 4-2-6. Measurement of time interval



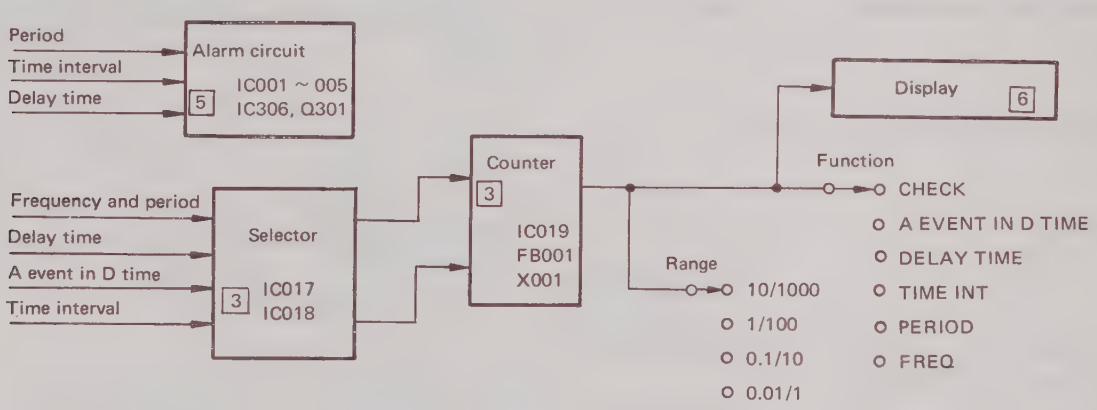
By pressing the RESET switch, the operation is initialized and is set in waiting state. LED indication thus returns to zero.

The alarm circuit receives the signal to measure period, time interval, dealy time, and emits an inhibit alarm in the following cases;

- When LF-HF is set to LF for period measurement, and the period of signal being measured is from 0.2 μs to 0.4 μs or less.
- When the START or STOP cursor is set for time interval measurement so that the time interval (intensity modulation portion on the CRT screen) is from 0.2 μs to 0.4 μs or less.
- When the delay time is set from 0.2 μs to 0.4 μs or less for delay time measurement.

When an alarm occurs, the unit display lamp flasches. At this time, after correcting the range from 0.2 μs to 0.4 μs or more, restart the measurement.

Figure 4-2-7. Block diagram of control circuit



Section 4 Circuit Description

4-2-5 Power Supply [4]

The low-voltage supply circuit is as shown in Figure 4-2-8. It has three independent stabilized power supplies to operate the universal counter unit stably.

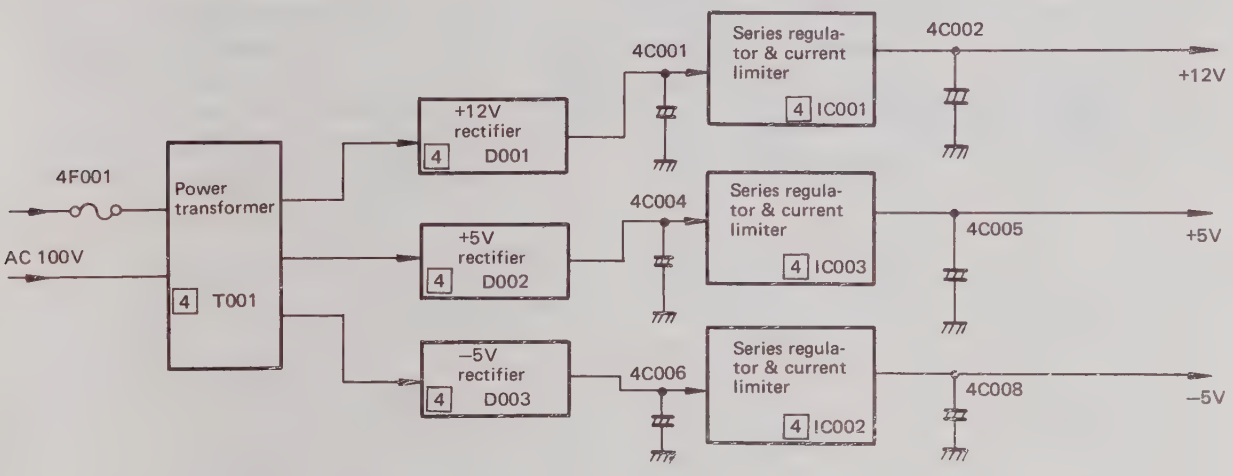
The stabilized power supply circuits provide the stable output voltage with low ripple not affected by load variations, and, if the outputs are grounded, they are protected from damages by means of the protective circuit.

The voltage to the power input is supplied from the primary 100-V winding terminal of the low-voltage power transformer of the oscilloscope unit. Thus, if the AC supply connected to the oscilloscope unit is other than 100 V, 100V ac is always supplied to the power input of the counter unit.

The output voltage of the power transformer is applied to the rectifier circuits of +12 V, +5 V, and −5 V, undergoes full-wave rectification by 4D001, 4D002 and 4D003, then smoothed by electrolytic capacitors and becomes d.c. voltage.

The d.c. voltage is applied to the series regulator, current limiter, and error amplifier, 4IC001, 4IC002, and 4IC003 respectively. Thus, the stabilized voltage −5 V is output from the pin 2 of 4IC002, +5 V from the pin 2 of 4IC003, and +12 V from the pin 2 of 4IC001. The stabilized output voltages are supplied each circuit of the universal counter unit.

Figure 4-2-8. Block diagram of power supply



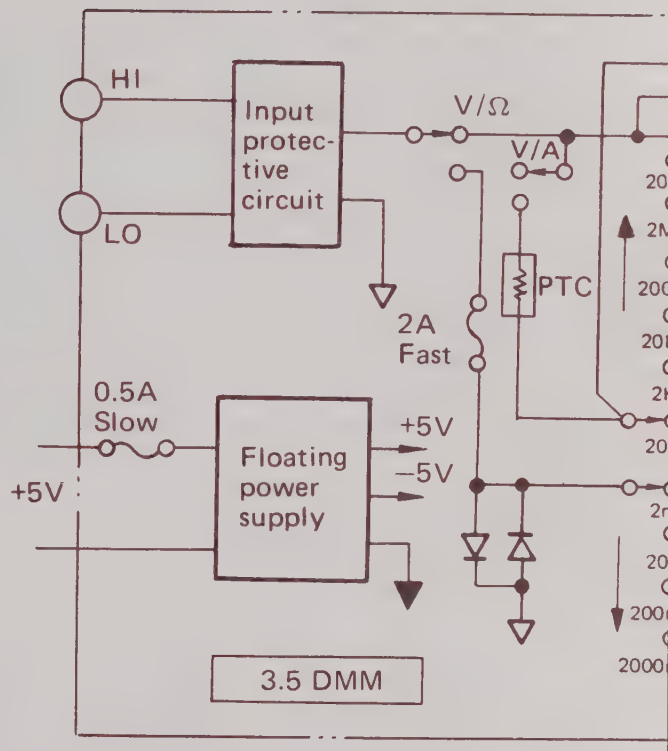
4-3 DIGITAL MULTIMETER UNIT

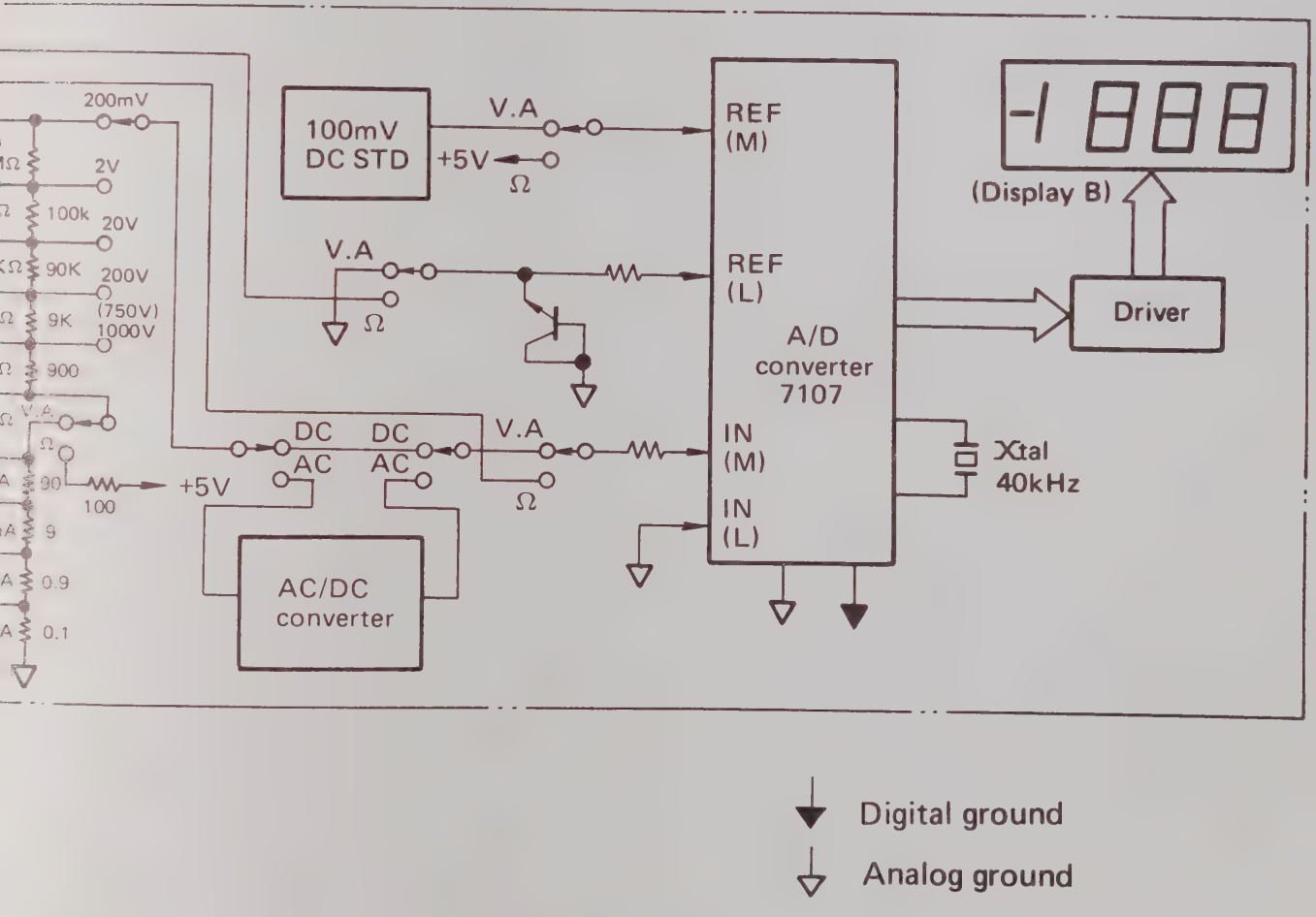
4-3-1 General Description

The digital multimeter circuit configuration is as shown in figure 4-3-1. The digital multimeter unit is independent of the oscilloscope unit, thus permitting the measurement to be made independently.

The measurement functions inlcudes that of dc voltage and current, ac voltage and current, and resistance. The measured results are displayed on LEDs (red). The signal input terminal Hi-Lo of the digital multimeter is floated from ground, and as a result, the potential at the ground side is divided into two kinds: the analog ground potential and the digital ground potential. If an external high voltage enters from the signal input terminal, the digital multimeter circuits are protected from damage by means of the protection circuit consisting of the discharge element and the surge absorber.

Figure 4-3-1. Block diagram of digital multimeter





Digital ground

Analog ground

4-3-2 Input Circuit and Attenuator [1]

The input circuit and attenuator are as shown in Figure 4-3-2.

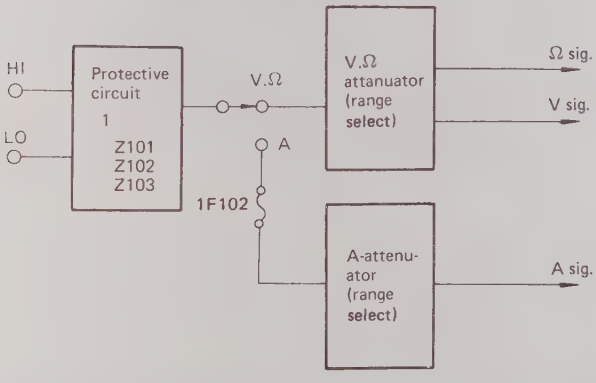
If a high voltage enters from the outside to the input circuit, the circuit may be damaged in some case. The protective circuit 1Z101, 1Z102 and 1Z103, by using the discharge elements and the surge absorber protects the circuit from damages. So that the high voltage does not enter the input circuit.

There are two attenuator circuits: one attenuator selects the proper range depending on the signal to be measured when ac or dc voltage (V) resistance (Ω) is measured; the other selects the proper range depending on the signal to be measured when ac or dc current (A) is measured.

In the current measurement, the fuse 1F102 is designed to be blown by 2-A or more signal current to protect the circuits.

Measurement signals of resistance, dc voltage and current are directly guided to the A/D converter through the attenuator. Measurement signals of ac voltage and current are guided to AC/DC converter through the attenuator.

Figure 4-3-2. Input circuit and attenuator block diagram



4-3-3 AC/DC and A/D Converters [1], [2]

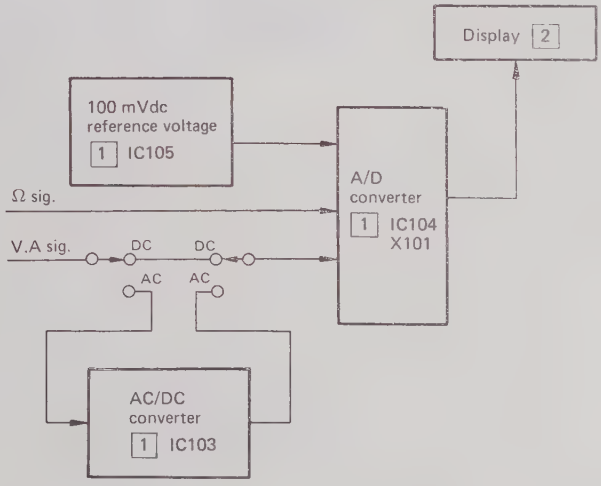
The AC/DC and A/D converters circuits are as shown in Figure 4-3-1.

The ac voltage and current signals applied to the AC/DC converter 1IC03 are rectified and converted to dc voltage and current signals, and are output as the rms values, The converted signals are guided to the A/D converter.

The 100-mV reference voltage is provided by means of 1IC105 from the +5 V supply voltage and is supplied to the A/D converter as the reference voltage. The 1R121 is the variable resistor to calibrate 200-mV range when the function is set to dc voltage.

The A/D converter 1IC104 converts the input analog signal to a digital signal. The converted digital signal is displayed on LEDs. The 40 kHz clock signal generated by the crsytal oscillator is applied to the converter and is used for time measurement of the analog signal and the result is converted to a digital signal.

Figure 4-3-3. Block diagram of AC/DC and A/D converters



4-3-4 Power Supply [1]

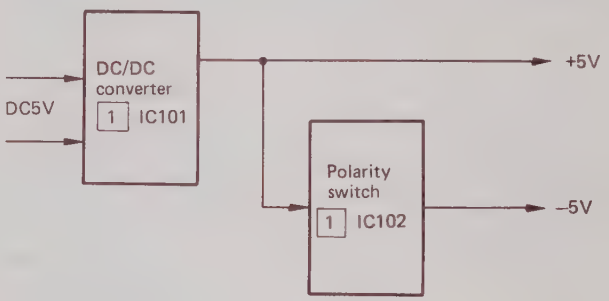
The power supply is as shown in Figure 4-3-4.

To the input of the power supply, stabilized +5 V is supplied from the power supply of the universal counter. The voltage is applied via the fuse 1F101 to the DC/DC converter.

The DC/DC converter 1IC101 is used to float the potential at the ground side of the multimeter circuit from the ground potential. Therefore, the minus side potential of the input to the DC/DC converter is grounded, but the minus potential of the output voltage is floated from the ground potential specific to the digital unit. As a result, in the DC/DC converter, the input and output sides are not in dc connection. The output of +5V power supply is branched so that the one of +5 V is supplied directly to each circuit of the digital multimeter and the other +5 V is supplied to the polarity switch.

The polarity switch 1IC102 converts the +5 V power supply to the output of stabilized −5 V power supply. If the output voltage is short-circuited to the ground potential, 1IC102 is protected by the protective circuit so that the stabilized power supply circuit is not damaged. The output of the stabilized −5 V is suppled to each circuit of the digital multimeter unit.

Figure 4-3-4. Block diagram of power supply



NOTES

Section 5

Maintenance

This section describes the maintenance procedures for keeping the SS-5711D in good condition over a long period of time. If it becomes necessary to check and replace the circuit parts, refer to the Circuit Arrangement Diagrams.

Apart from the instructions given in this section, the proper operation procedures described in section 2 must also be observed to assure long satisfactory operation.

5-1 PREVENTIVE MAINTENANCE

These are the preventive maintenance procedure for preventing troubles and keeping your oscilloscope clean and well for a long period of time.

5-1-1 Cleaning

The extent of dirt varies according to the ambient condition in which the instrument is used. The instrument should be cleaned as required. Dirt accumulated in the instrument causes overheating because it interrupts effective heat dissipation. It also damages the parts under high-humidity condition. A dirty switch contact or connector can cause faulty contact, and dirt accumulated on the inner circuit part can cause spark during the wet season. The fluids suitable or unsuitable for cleaning the instrument are shown in table 5-1.

Table 5-1

Suitable fluids	Alcohol, water, neutral detergent
Unsuitable fluido	Acetone gasoline, ether, lacquer thinner, methylethyl ketone, chemicals containing ketone detergent

Cover Cleaning

Remove the covers, and clean them with detergent. Remove stains of grease using a soft cloth damped with one of the suitable fluids shown in Table 5-1.

Front Panel Cleaning

Wet a soft cloth with one of the suitable fluids shown in table 5-1, and clean the front panel with it. If alcohol is used, some traces might be left. The front panel can also be cleaned with detergent. In this case, it is necessary to wipe off the detergent left on the panel and the control knobs with a cloth dampened with water.

Inside Cleaning

The best way of cleaning the dirt accumulated in the instrument is to use an air compressor. Dirt which remains after blowing with air compressor can be removed by using a soft paint brush and blowing again with air compressor.

CRT and Filter Cleaning

The CRT screen and the filter can become dirty if they are used for a long time. Ordinary stains and fingerprints can be removed by wiping with a soft cloth. If they are terribly dirty, use a soft cloth dampened with alcohol.

5-1-2 If Unused for a Long Time

If you don't use the instrument for a long time, remove the probe, adaptor, etc. From it and put them in the supplied bag. Attach the supplied panel cover to it, put the dust cover on the device, and store it in a place as dry as possibele.

This can keep the instrument clean.

5-1-3 Checking

Inspect the inside of the instrument periodically for burnt resistors, faulty contacts, or damaged printed circuit boards. Major troubles can be prevented by repairing them immediately.

5-1-4 Periodic Adjustment

Periodic inspection and adjustments are necessary for keeping the instrument in accurate operating condition at all times. If the instrument is continuously used, inspect and adjust it about every 1000 hours. If it is not used so much, it may be inspected and adjusted about every six months.

5-2 PARTS REPLACEMENT

The replacement procedures for faulty parts detected by circuit inspection are described here. Be sure to disconnect the power cord from the electrical outlet before replacing any faulty parts.

5-2-1 Cover Removal

The covers must be removed before inspecting the inside or replacing faulty parts.

Be sure to remove the rear panel first in removing the covers. The rear panel can be removed by removing the two each screws on the right and left of the panel. Then, remove the six screws from the top, left, and right sides of the top cover in its front and rear parts, and slide the cover slightly to rear ward. Next, widen on both root of the handle and pull up the cover.

Remove one each screw in the front and rear parts of the bottom cover and the two screw near the center of it, and remove the bottom cover by pulling rearward. (The front end of the bottom cover is inserted behind the front panel).

5-2-2 Printed Circuit Board Removal

To replace a faulty printed circuit board or a faulty parts on a printed circuit board, remove the printed circuit board.

The instrument has separate printed circuit boards for the V-unit, H-unit, and others.

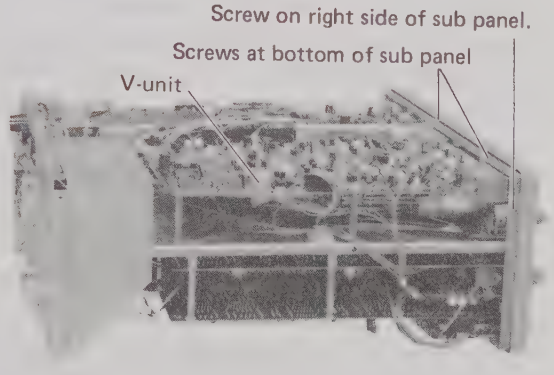
The printed circuit board for the V-unit consists of the following circuits.

CH 1 preamplifiers (1), (2)
CH 2 preamplifers (1), (2)
Delay cable driver
Vertical control
Vertical panel switches

The V-unit removal procedure is as follows.

1. Remove the control knobs VOLTS/DIV, VARIABLE, POSITION and GND REF for CH 1 and CH 2.
2. Remove the two screws on the bottom of the sub panel and the screw form the right side of it.
3. Remove the two screws over the CH 1 and CH 2 INPUT connectors on the front panel.
4. Remove the four screws that fasten the printed circuit board.
5. Remove the V-unit by sliding it rearward.

Figure 5-1. External View of the V-Unit



(This photo shows the instrument upside down.)

The printed circuit board for H-unit consists of the following.

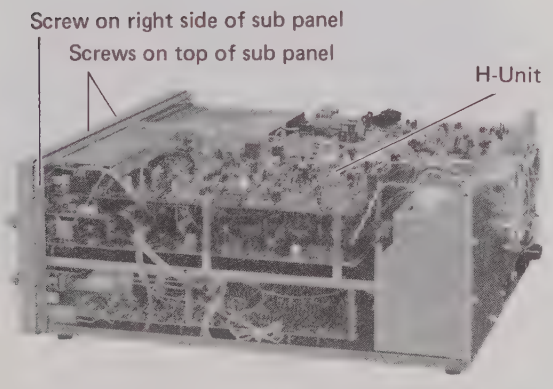
CH 3 and CH 4 attenuators and preamplifiers
TV sync separator
A trigger generator
B trigger generator
B sweep generator

The H-unit removal procedure is as follows.

1. Remove the two screws on top of the sub panel and the screw on the right side of it.
2. Remove the two screws over the CH 3 and CH 4 INPUT connectors on the front panel.
3. Disconnect the connectors for the leads that are connected to other printed circuit boards.
4. Remove the four screw that fasten the printed circuit board.
5. Remove the H-unit by sliding it rearward.

To remove the individual printed circuit boards, remove the pin connectors and multi-connectors that are connected to them first and them the control knobs and rotary switches from the front panel and the screws that fasten the printed circuit boards.

Figure 5-2. External View of H-Unit



5-2-3 Printed Circuit Board Parts Replacement

In replacing diodes, transistors, IC's , resistors, or capacitors, on a printed circuit board, use your soldering iron carefully so that neither the copper foil of the printed circuit board will be peeled off nor any parts on the circuit board will be damaged.

Because the semiconductors, such as transistors and diodes, are not thermal-resistant, pinch the leads with tweezers and solder them quickly component so that the heat of the soldering iron will not be directly conveyed to the semiconductor. Diodes and transistors used for replacement must have good performance.

The resistors, capacitors, and other passive elements used in the instrument are carefully selected so any replacement parts to be used in their place must have good ones. (See the parts list in section 8.)

Electrode contact of transistor or diode and serious variation of their characteristics may incidentally make a resistor burn or a capacitor short-circuit. If such a trouble should occur, eliminate the cause of it before replacing the faulty part.

5-2-4 Replacing Resistors, Diodes or IC's

In replacing a transistor, diode, or IC, make sure of the electrodes. (See tables 5-4, 5-5, and 5-6.)

Particularly, transistors must be replaced with ones that have good performance. The transistors that have been specially selected are moted in the schematic diagrams.

5-2-5 Power Transistor Replacement

The power transistors for the instrument are mounted on the rear sub panel. In replacing any of them, remove the rear panel, and remove the screw that fastens the transistor. The power transistors are connected with a connector.

In installing a new transistor, first wind heat dissipating silicon rubber (TC-30) around the transistor to assure satisfactory heat dissipation between the transistor and sub panel, and install the transistor. Be sure to insert it into the connector in the correct direction. (Connect the brown lead of the connector to pin 1 of the transistor, and the orange lead one to pin 2 of the transistor.)

5-2-6 CRT Replacement

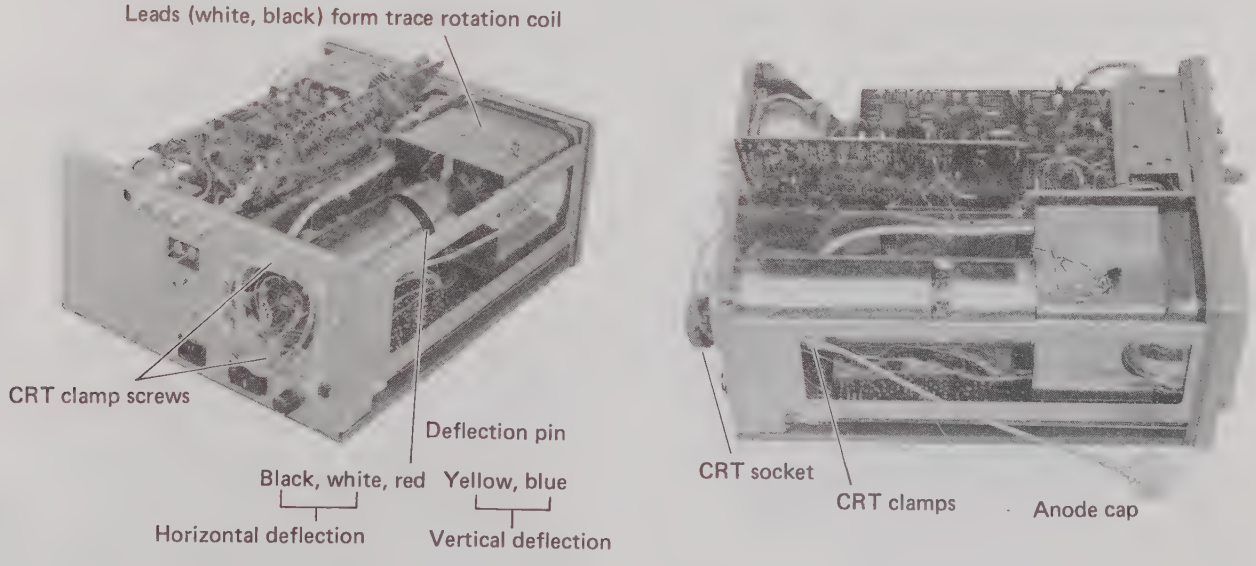
Handle the CRT carefully in replacing it because it will be damaged easily by dropping or shock. Care must be also taken not to apply too much strain to the deflection pin to prevent the glass from cracking.

The CRT removal procedure is as follows:

1. Remove the rear panel and the top cover.
2. Disconnect the CRT socket.
3. Remove the anode cap after discharging it because it might retain a high voltage charge.
4. Disconnect the wires from the delfection pin.
   The blue and yellow leads are for vertical deflection, the white and black leads for horizontal deflection, and the red lead is for the negative electrode of Q3 of V1 (CRT).
   Disconnect the leads with care so that they will not be rewired to the deflection pin in the wrong way.
5. Disengage the connector at the tip for the trace rotation coil leads (white, black).
6. Pull out the ORTHO leads (green blue).
7. Remove the four screws that fasten the printed circuit board (V main amplifer) over the CRT, and lift it slightly.
8. Remove the two screws that fasten the CRT clamps to the rear sub panel.
9. Loosen the long screws for the CRT clamps that fasten the CRT.
10. Slightly pull the CRT and shield case rearward, lift the front end of the CRT and pull it forward until it comes out.
11. Pull the CRT carefully from the shield case.

Reverse the above procedure for installing the CRT. If the CRT has been replaced, readjustments must be made by referring to section 6 Performance (Check) and Adjustment.

Figure 5-3. CRT and its Peripheral Parts



5-2-7 High-Voltage Power Transformer Replacement

Care must be taken in replacing the high-voltage power transformer which supplies high voltage to the CRT because the CRT cicuit may be live with high voltage. The removal procedure is as follows:

1. Remove the rear panel, and top and bottom covers.
2. Remove the two screws that fasten the high-voltage case, and remove the case.
3. Remove the three screws that fasten the printed circuit board for the high-voltage circuit, disengage the printed circuit board connector and transistor connector, and remove the printed circuit board.
4. The high-voltage power transformer is soldered on the printed circuit board. It must be unsoldered by using a soldering iron. When the high-voltage power transformer has been replaced, readjustment is necessary.

5-2-8 Replacing Control Knobs and Rotary Switches

The control knobs and rotary switches are mounted on the printed circuit boards and the front sub panel. Their replacement procedure is as follows:

1. Remove the screw from the printed circuit board on which the control knob or rotary switch to be replaced is mounted.
2. Disengage the connector that is connected to the printed circuit board.
3. Remove the control knob or rotary switch.
4. Remove the nut which fastens the contol or rotary switch, and remove it together with the printed circuit board. (Refer to the Hand V-unit removal procedures mentioned before.)
5. Melt the solder that fastens the control or rotary switch, using a sodering iron. Reverse the above procedure for installing them.

5-2-9 Replacing Pushbutton Switches

Pushbutton Switches for the H– and V–Units

After following the removal procedure of the H–/V–unit removal procedure mentioned before, remove the pushbutton switch from the printed circuit board, using a soldering iron. The replacement procedure for the HORIZ DISPLAY and horizontal MODE pushbuttons is as follows:

HORIZ DISPLAY and Horizontal MODE Pushbuttons

Follow the removal procedure of the H–/V–unit, remove the front panel, and proceed as follws:

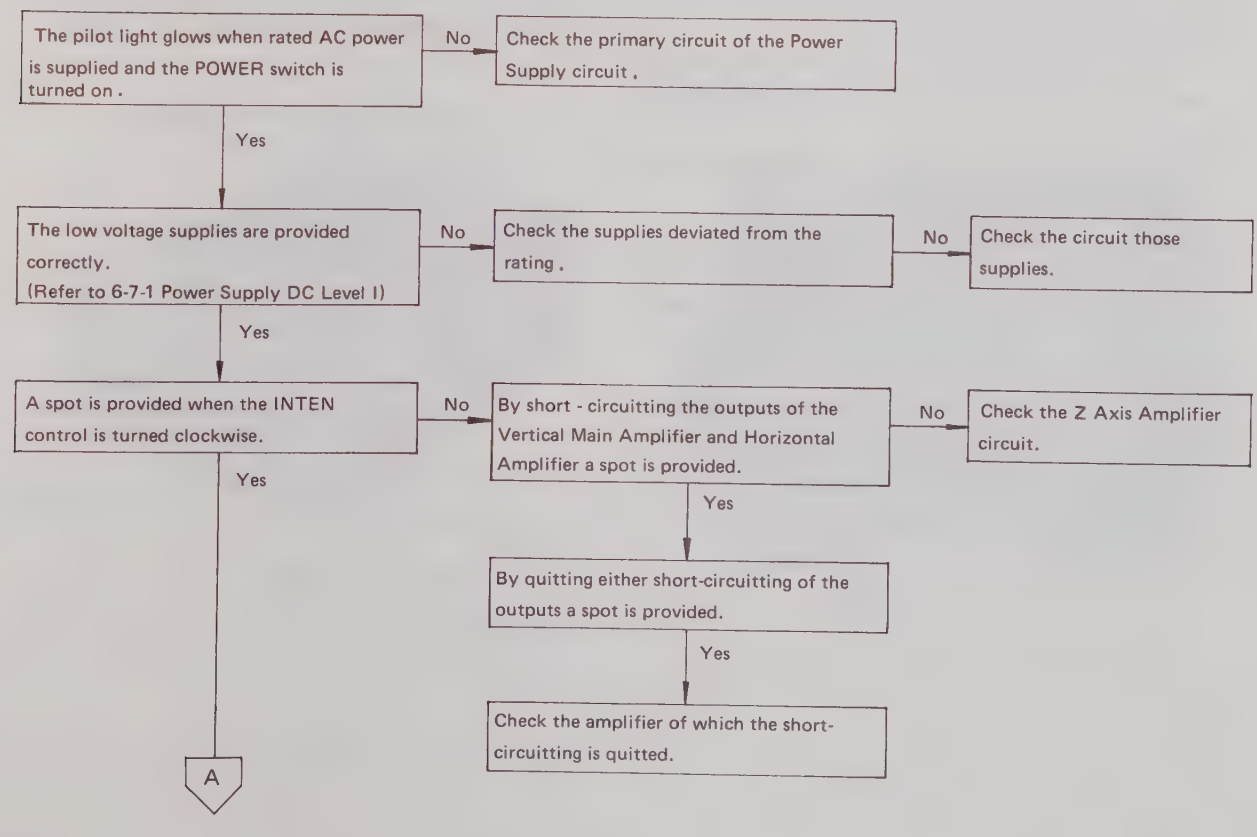
1. Remove the nuts that fasten the A and B TIME/DIV switches, horizontal POSITION control, HOLDOFF control, and TRACE SEPARATION control form the sub panel.
2. Remove the A-sweep printed circuit board.
3. Remove the two each screws that fasten the HORIZ DISPLAY and horizontal MODE switches from the sub panel, and remove them together with the printed circuit board.
4. Melt the solder that fastens the printed circuit board by using a soldering iron, and remove the switches.

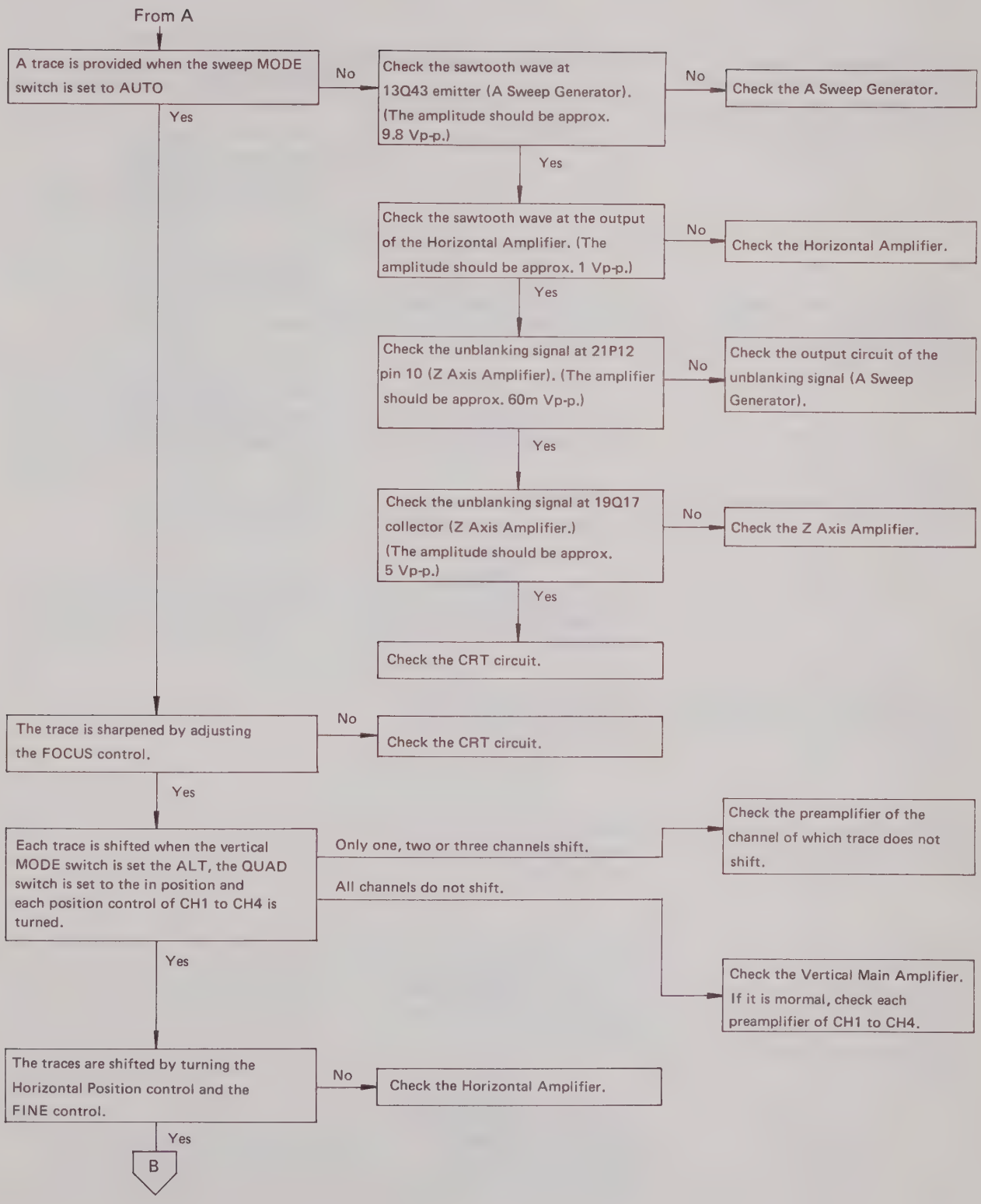
TROUBLESHOOTING FLOW CHART

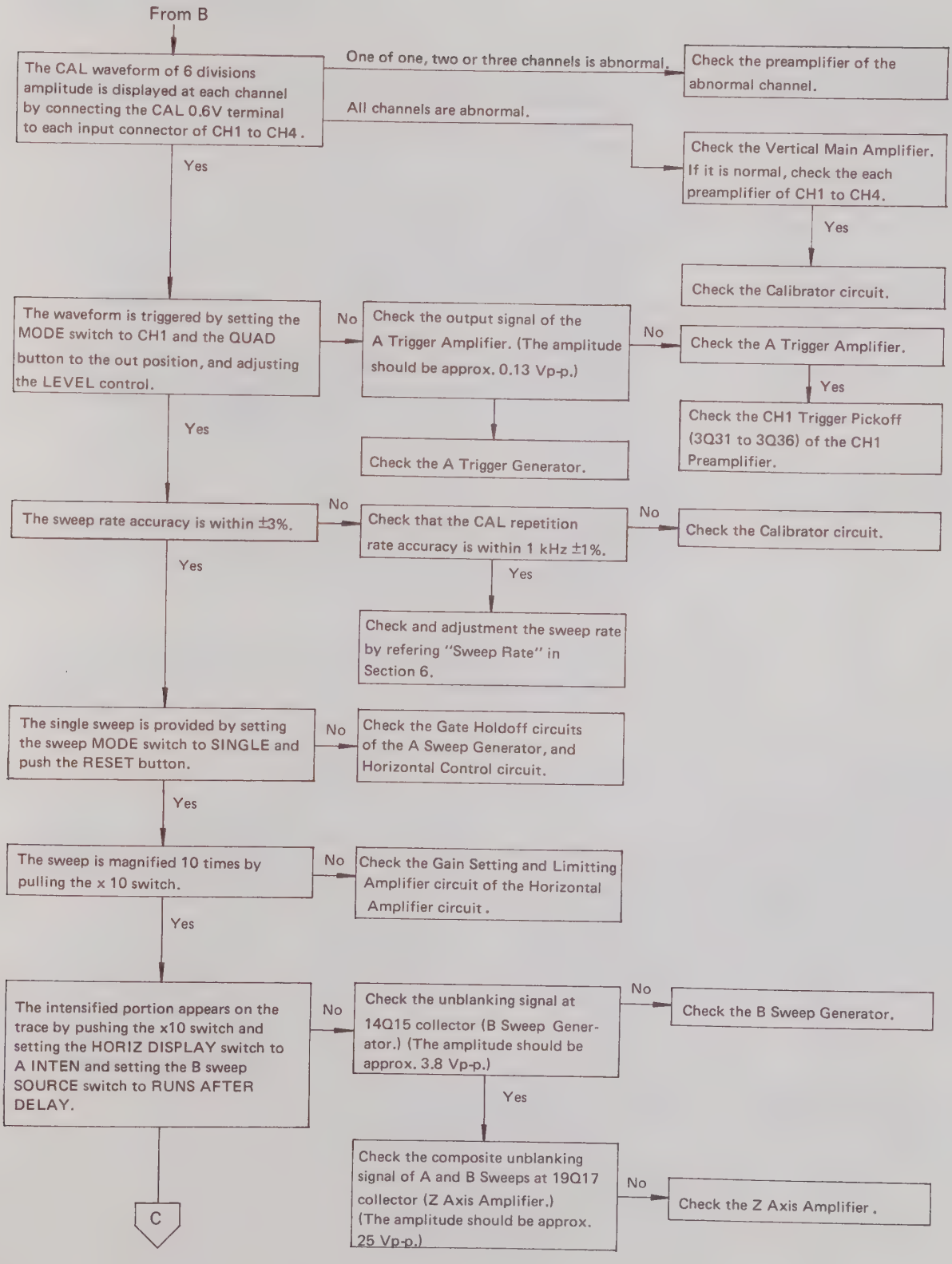
Oscilloscope Section

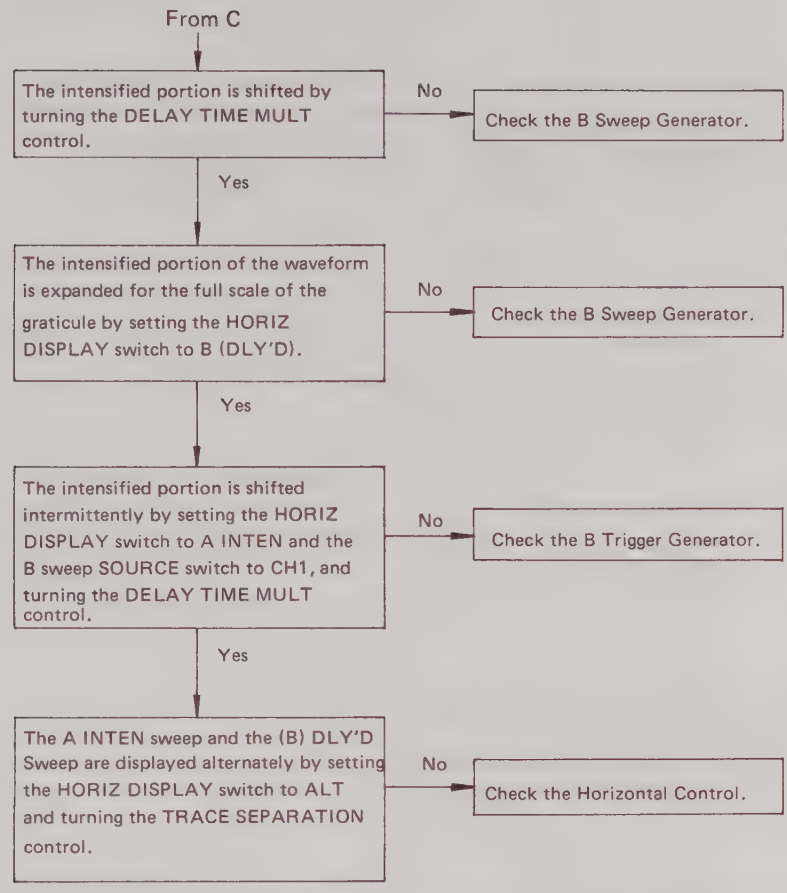
First, set the switches and controls as follows;

POWER	Off	FINE (PULL x10 MAG)	Push, Mid-position
INTEN	Mid-position	COUPLING (A, B)	AC
FOCUS	Mid- position	SOURCE (A, B)	CH1
SCALE	Fully clockwise	HOLDOFF	Fully counterclockwise
MODE (vertical)	CH1	MODE (sweep)	AUTO
POSITION (CH1, CH2)	Mid-position	LEVEL/SLOPE (A, B)	Push, Mid-position
(PULL x5 MAG) (CH1, CH2)	Push	A TIME/DIV	1 msec
VOLTS/DIV (CH1, CH2)	0.1V	B TIME/DIV	0.1 msec
VARIABLE (CH1, CH2)	CAL	A VARIABLE	CAL
AC-DC, GND (CH1, CH2)	DC	HORIZ DISPLAY	A
CH2 POLAR	Out	DELAY TIME MULT	Fully counterclockwise
BAND WIDTH	Out	TRACE SEPARATION	Fully counterclockwise
POSITION (CH3, CH4)	Mid-position	0.1V-1V (CH3, CH4)	0.1V
⟷ POSITION	Mid-position	AC-DC (CH3, CH4)	DC


The pilot light glows when rated AC power is supplied and the POWER switch is turned on .
No
Check the primary circuit of the Power Supply circuit .
Yes
The low voltage supplies are provided correctly.
(Refer to 6-7-1 Power Supply DC Level I)
No
Check the supplies deviated from the rating .
No
Check the circuit those supplies.
Yes
A spot is provided when the INTEN control is turned clockwise.
No
By short - circuitting the outputs of the Vertical Main Amplifier and Horizontal Amplifier a spot is provided.
No
Check the Z Axis Amplifier circuit.
Yes
Yes
By quitting either short-circuitting of the outputs a spot is provided.
Yes
Check the amplifier of which the short-circuitting is quitted.
A


From A
A trace is provided when the sweep MODE switch is set to AUTO
No
Check the sawtooth wave at 13Q43 emitter (A Sweep Generator). (The amplitude should be approx. 9.8 Vp-p.)
No
Check the A Sweep Generator.
Yes
Yes
Check the sawtooth wave at the output of the Horizontal Amplifier. (The amplitude should be approx. 1 Vp-p.)
No
Check the Horizontal Amplifier.
Yes
Check the unblanking signal at 21P12 pin 10 (Z Axis Amplifier). (The amplifier should be approx. 60m Vp-p.)
No
Check the output circuit of the unblanking signal (A Sweep Generator).
Yes
Check the unblanking signal at 19Q17 collector (Z Axis Amplifier.) (The amplitude should be approx. 5 Vp-p.)
No
Check the Z Axis Amplifier.
Yes
Check the CRT circuit.
The trace is sharpened by adjusting the FOCUS control.
No
Check the CRT circuit.
Yes
Each trace is shifted when the vertical MODE switch is set the ALT, the QUAD switch is set to the in position and each position control of CH1 to CH4 is turned.
Only one, two or three channels shift.
Check the preamplifier of the channel of which trace does not shift.
All channels do not shift.
Check the Vertical Main Amplifier. If it is mormal, check each preamplifier of CH1 to CH4.
Yes
The traces are shifted by turning the Horizontal Position control and the FINE control.
No
Check the Horizontal Amplifier.
Yes
B

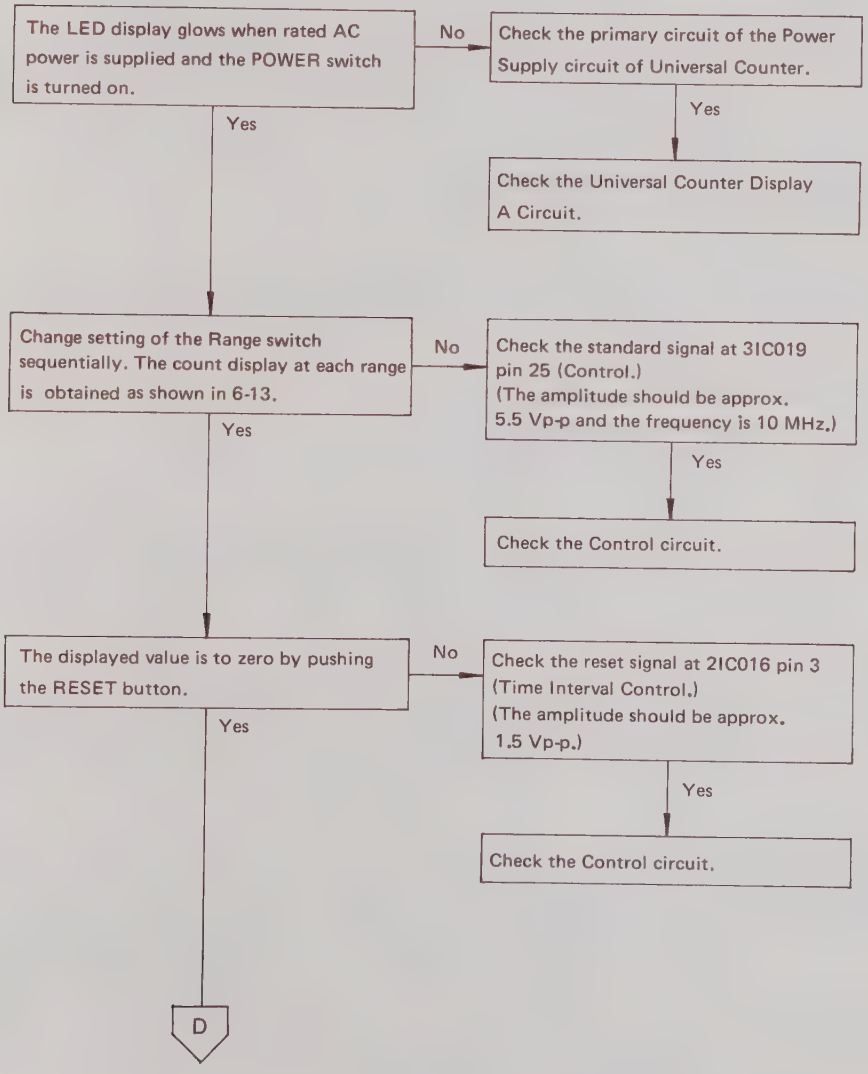

From B
The CAL waveform of 6 divisions amplitude is displayed at each channel by connecting the CAL 0.6V terminal to each input connector of CH1 to CH4.
One of one, two or three channels is abnormal.
Check the preamplifier of the abnormal channel.
All channels are abnormal.
Check the Vertical Main Amplifier. If it is normal, check the each preamplifier of CH1 to CH4.
Yes
Yes
Check the Calibrator circuit.
The waveform is triggered by setting the MODE switch to CH1 and the QUAD button to the out position, and adjusting the LEVEL control.
No
Check the output signal of the A Trigger Amplifier. (The amplitude should be approx. 0.13 Vp-p.)
No
Check the A Trigger Amplifier.
Yes
Check the CH1 Trigger Pickoff (3Q31 to 3Q36) of the CH1 Preamplifier.
Yes
Check the A Trigger Generator.
The sweep rate accuracy is within ±3%.
No
Check that the CAL repetition rate accuracy is within 1 kHz ±1%.
No
Check the Calibrator circuit.
Yes
Yes
Check and adjustment the sweep rate by refering "Sweep Rate" in Section 6.
The single sweep is provided by setting the sweep MODE switch to SINGLE and push the RESET button.
No
Check the Gate Holdoff circuits of the A Sweep Generator, and Horizontal Control circuit.
Yes
The sweep is magnified 10 times by pulling the x 10 switch.
No
Check the Gain Setting and Limitting Amplifier circuit of the Horizontal Amplifier circuit.
Yes
The intensified portion appears on the trace by pushing the x10 switch and setting the HORIZ DISPLAY switch to A INTEN and setting the B sweep SOURCE switch to RUNS AFTER DELAY.
No
Check the unblanking signal at 14Q15 collector (B Sweep Generator.) (The amplitude should be approx. 3.8 Vp-p.)
No
Check the B Sweep Generator.
Yes
Check the composite unblanking signal of A and B Sweeps at 19Q17 collector (Z Axis Amplifier.) (The amplitude should be approx. 25 Vp-p.)
No
Check the Z Axis Amplifier.
C

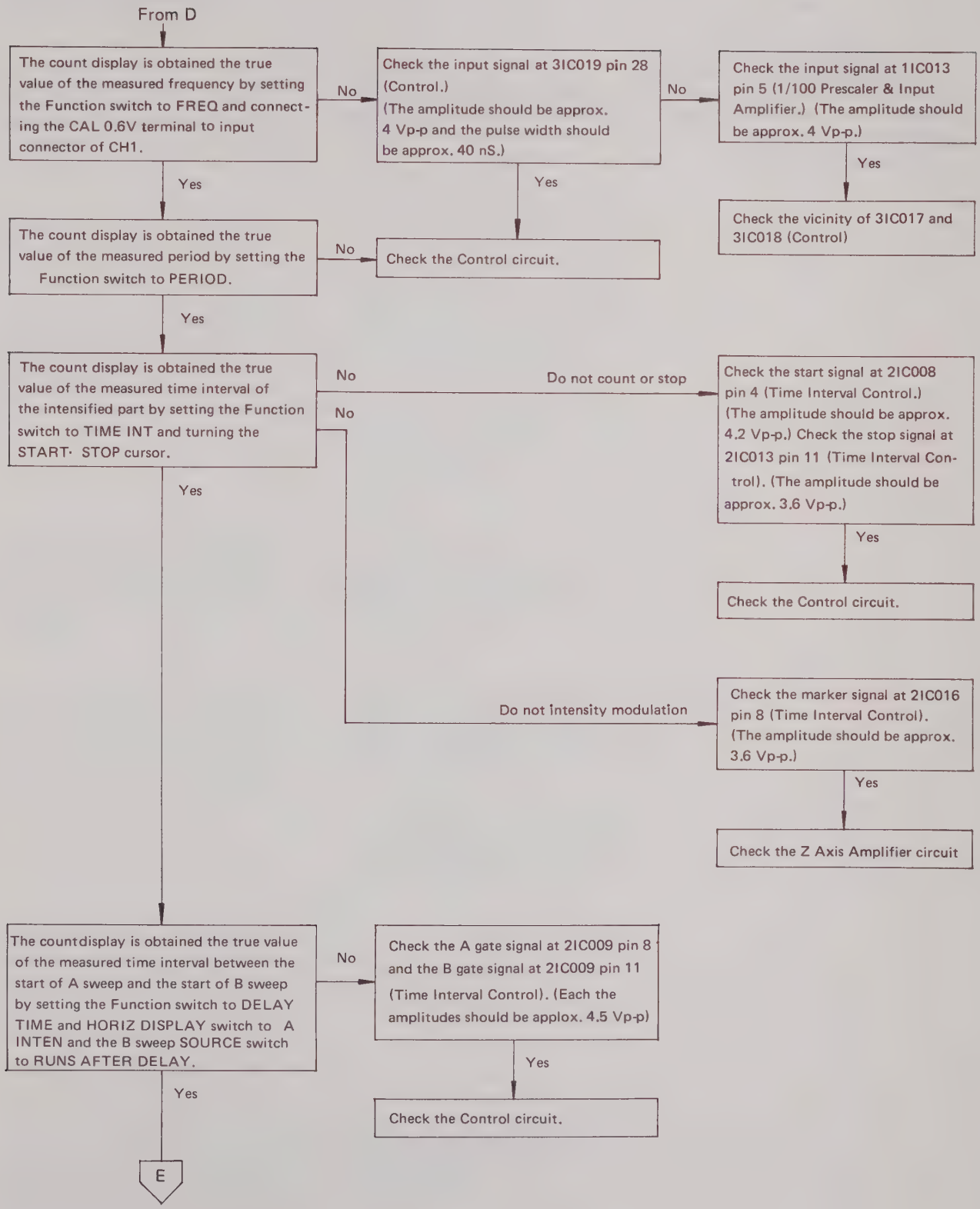

From C
The intensified portion is shifted by turning the DELAY TIME MULT control.
No
Check the B Sweep Generator.
Yes
The intensified portion of the waveform is expanded for the full scale of the graticule by setting the HORIZ DISPLAY switch to B (DLY'D).
No
Check the B Sweep Generator.
Yes
The intensified portion is shifted intermittently by setting the HORIZ DISPLAY switch to A INTEN and the B sweep SOURCE switch to CH1, and turning the DELAY TIME MULT control.
No
Check the B Trigger Generator.
Yes
The A INTEN sweep and the (B) DLY'D Sweep are displayed alternately by setting the HORIZ DISPLAY switch to ALT and turning the TRACE SEPARATION control.
No
Check the Horizontal Control.

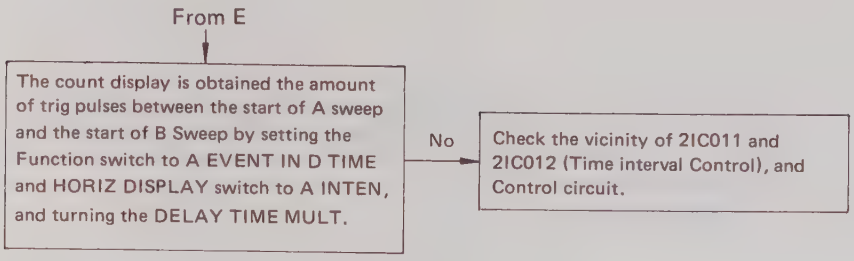
Universal Counter Section

First, set the switches and controls as follows;

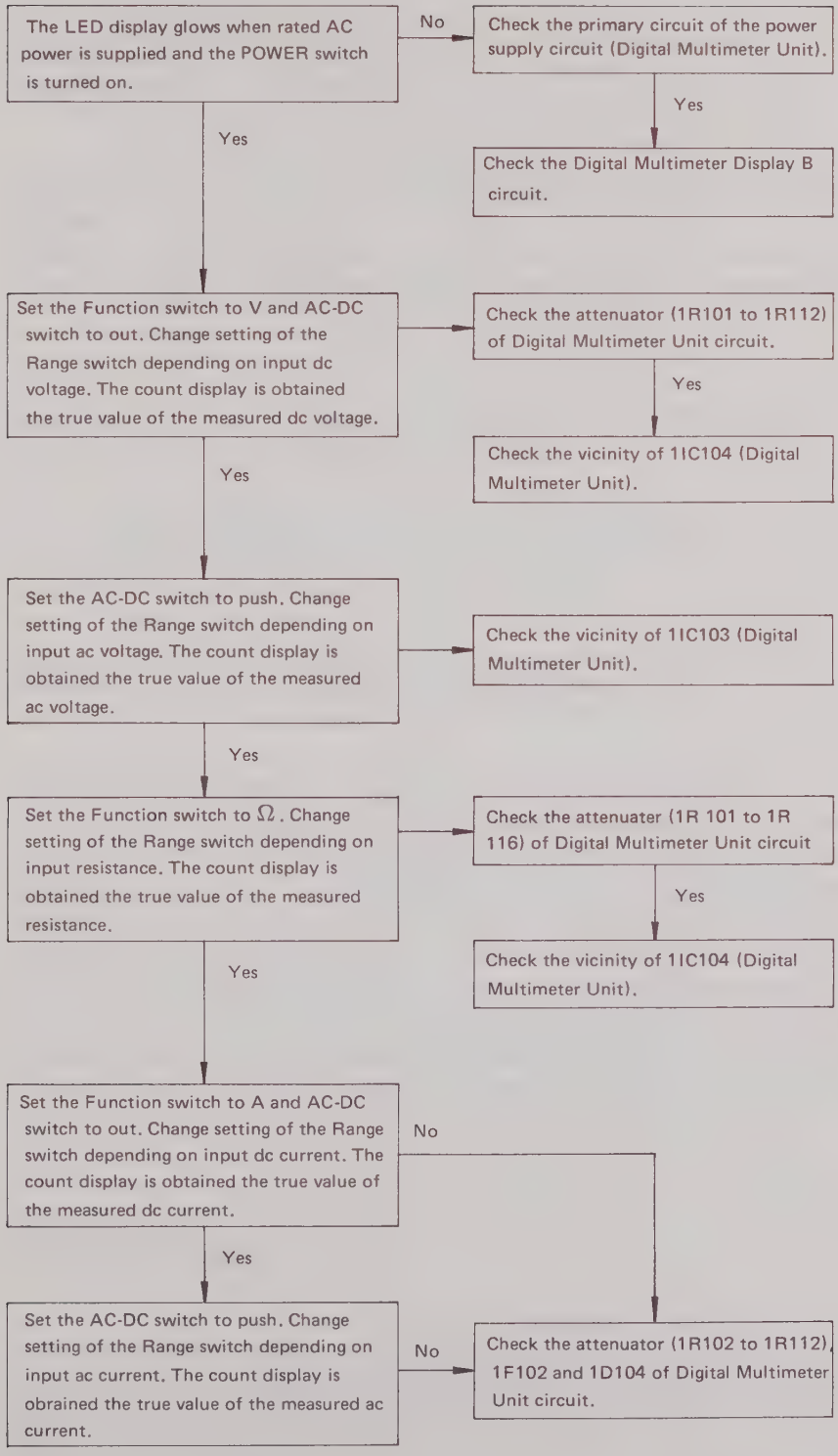
Function	Push, CHECK button	START	Counterclockwise
Range	0.01	STOP	Mid-position
HF-LF	Out		
EXT-INT	Out	Osilloscope	Refer to Oscilloscope Section


The LED display glows when rated AC power is supplied and the POWER switch is turned on.
No
Check the primary circuit of the Power Supply circuit of Universal Counter.
Yes
Check the Universal Counter Display A Circuit.
Yes
Change setting of the Range switch sequentially. The count display at each range is obtained as shown in 6-13.
No
Check the standard signal at 3IC019 pin 25 (Control.) (The amplitude should be approx. 5.5 Vp-p and the frequency is 10 MHz.)
Yes
Check the Control circuit.
Yes
The displayed value is to zero by pushing the RESET button.
No
Check the reset signal at 2IC016 pin 3 (Time Interval Control.) (The amplitude should be approx. 1.5 Vp-p.)
Yes
Check the Control circuit.
Yes
D


From D
The count display is obtained the true value of the measured frequency by setting the Function switch to FREQ and connecting the CAL 0.6V terminal to input connector of CH1.
No
Check the input signal at 3IC019 pin 28 (Control.) (The amplitude should be approx. 4 Vp-p and the pulse width should be approx. 40 nS.)
No
Check the input signal at 1IC013 pin 5 (1/100 Prescaler & Input Amplifier.) (The amplitude should be approx. 4 Vp-p.)
Yes
Yes
Yes
Check the vicinity of 3IC017 and 3IC018 (Control)
The count display is obtained the true value of the measured period by setting the Function switch to PERIOD.
No
Check the Control circuit.
Yes
The count display is obtained the true value of the measured time interval of the intensified part by setting the Function switch to TIME INT and turning the START· STOP cursor.
No
Do not count or stop
Check the start signal at 2IC008 pin 4 (Time Interval Control.) (The amplitude should be approx. 4.2 Vp-p.) Check the stop signal at 2IC013 pin 11 (Time Interval Control). (The amplitude should be approx. 3.6 Vp-p.)
No
Yes
Yes
Check the Control circuit.
Do not Intensity modulation
Check the marker signal at 2IC016 pin 8 (Time Interval Control). (The amplitude should be approx. 3.6 Vp-p.)
Yes
Check the Z Axis Amplifier circuit
The countdisplay is obtained the true value of the measured time interval between the start of A sweep and the start of B sweep by setting the Function switch to DELAY TIME and HORIZ DISPLAY switch to A INTEN and the B sweep SOURCE switch to RUNS AFTER DELAY.
No
Check the A gate signal at 2IC009 pin 8 and the B gate signal at 2IC009 pin 11 (Time Interval Control). (Each the amplitudes should be applox. 4.5 Vp-p)
Yes
Yes
Check the Control circuit.
E


From E
The count display is obtained the amount of trig pulses between the start of A sweep and the start of B Sweep by setting the Function switch to A EVENT IN D TIME and HORIZ DISPLAY switch to A INTEN, and turning the DELAY TIME MULT.
No
Check the vicinity of 2IC011 and 2IC012 (Time interval Control), and Control circuit.

Digital Multi-meter Section


The LED display glows when rated AC power is supplied and the POWER switch is turned on.
No
Check the primary circuit of the power supply circuit (Digital Multimeter Unit).
Yes
Check the Digital Multimeter Display B circuit.
Yes
Set the Function switch to V and AC-DC switch to out. Change setting of the Range switch depending on input dc voltage. The count display is obtained the true value of the measured dc voltage.
Check the attenuator (1R101 to 1R112) of Digital Multimeter Unit circuit.
Yes
Check the vicinity of 1IC104 (Digital Multimeter Unit).
Yes
Set the AC-DC switch to push. Change setting of the Range switch depending on input ac voltage. The count display is obtained the true value of the measured ac voltage.
Check the vicinity of 1IC103 (Digital Multimeter Unit).
Yes
Set the Function switch to Ω. Change setting of the Range switch depending on input resistance. The count display is obtained the true value of the measured resistance.
Check the attenuater (1R 101 to 1R 116) of Digital Multimeter Unit circuit
Yes
Check the vicinity of 1IC104 (Digital Multimeter Unit).
Yes
Set the Function switch to A and AC-DC switch to out. Change setting of the Range switch depending on input dc current. The count display is obtained the true value of the measured dc current.
No
Yes
Set the AC-DC switch to push. Change setting of the Range switch depending on input ac current. The count display is obtrained the true value of the measured ac current.
No
Check the attenuator (1R102 to 1R112), 1F102 and 1D104 of Digital Multimeter Unit circuit.

NOTES

Check and Adjustment

6-1 GENERAL

Correct measurement requires the normal operation of each circuit in SS-5711D and satisfactory maintenance of their performance.

With the regular performance check and adjustment, SS-5711D can develop its functions in a reliable manner for a long period of service. This section describes the appropriate method of check and adjustment.

6-2 PERIOD OF CHECK AND ADJUSTMENT

The regular and periodical check and adjustment of performance is necessary for correct measurement. The proper check intervals for SS-5711D are six months.

6-3 PRECAUTIONS FOR CHECK AND ADJUSTMENT

For the performance check and adjustment, pay attention to the following:

a. In each check and adjustment items, the description for the control knob mainipulation presupposes the setting completed for item 6-6 Preparation. Whether the check and adjustment are carried out for all items or for limited items, make sure to start the operation from the point where the setting has been made according to the preparation for check and adjustment.
b. Some signal generator outputs at a 50 Ω termination; so using a coaxial cable with characteristic impedance of 50 Ω (e.g. BB-120 by Iwatsu), terminate the cable end at the scope side with a 50 Ω terminator (e.g. BB-50M1 by Iwatsu).
c. The low-voltage power is supplied to all circuits. If its voltage or ripple goes outside the specified values, the other performance will be affected. If check and adjustment, terefore, check the low-voltage power supply first.
d. The CRT has a high-voltage. For its check and adjustment, be careful not to catch an electric shock.
e. The adjuster has the circuit numbers. To make the circuit clear, the number in the boxes of the circuit diagrams are described before the circuit number.

6-4 EQUIPMENT REQUIRED

The check and adjustment requires the equipment and accessories as described in table 6-4-1. The equipment must have the performance equal to or greater than those described in the table. The signal connector of SS-5711D is BNC. If the terminator or signal output terminal is other than BNC, prepare a converter connector.

Table 6-4-1 List of equipment required

Equipment	Minimum Specifications	Purpose	Recommended Model
Scope calibrator • Standard-amplitude signal level • Time-mark geberator • Sine wave generator • Square wave generator • Fast rise signal generator	: 6mV to 60V ±0.5% or less : 10nsec to 2 sec ±0.05% or less : 1kHz ±20% Frequency range : 50Hz to 250kHz Rise time : 5nsec or less Repetition : 50kHz to 200kHz Rise time : 0.35nsec or less	Vertical, triggering and horizontal checks and adjustments	Iwatsu SC-340 TEKTRONIX PG506 Calibration Generator TG501 Time-Mark Generator (TM500-series power module mainframe is needed)
Standard signal generator	Frequency : 50kHz to 100 MHz Output level : 60mV or more	Pattern distortion, bandwidth and phase difference checks and adjustments	HP 8654A/B TEKTRONIX SG503 Leveled Sine-Wave Generator
Digital volt-meter	Range : DC to 200VDC ±0.05% + 1dgt	Power supply checks and adjustments	Iwatsu VOAC747 HP 3465A/B
High-voltage probe (For digital volt-meter)	Range : DC to 20k VDC ±3% + 1dgt	High-voltage power supply check and adjustment	Iwatsu High-voltage probe HP 34111A

Table 6-4-1 List of equipment required (cont.)

Equipment	Minimum Specifications	Purpose	Recommended Model
Test Oscilloscope and x1 probe (x1 probe is optional accessory)	Bandwidth : DC to 1MHz Minimum defection factor: 1mv/dv	Power supply ripple check and general troubleshooting	a. Iwatsu SS-5212 TEKTRONIX 213 Oscilloscope b. Iwatsu SS-0001/0002 TEKTRONIX P6101 Prove (x1)
Frequency counter	Range: 10Hz to 1.5MHz Resolution: 1Hz	Repetition rate of calibrator check	Iwatsu FC-8841 HP 5300/5301A
Voltage regulator		AC line voltage range check	
Termination (2 required)	Impedance: 50 Ω	Signal termination	Iwatsu BB-50MI
Divider		Signal interconnection	Iwatsu B-50D3
Cable (2 required)	Impedance: 50 Ω Length: 120mm	Signal interconnection	Iwatsu BB-120C
Supplied x10 probe		Signal interconnection	Iwatsu SS-0011
Screwdriver		Adjust variable resistors and capacitors	Iwatsu Probe accessory
VLF/LF TRACKING Receiver		Standard oscillator Check	Tracor : 599K

6-5 CHECK AND ADJUSTMENT ITEMS

The check and adjustment items are shown in table 6-5-1.
The right column indicates items that may be affected by adjustment.
Together with one item, also check and adjust other items that may be affected by that item.
In check and adjustment of all items, do them in the following sequence

Table 6-5-1 Items and interactions

order	Checks and adjustments items	Page	Checks and adjustments affected
	Power supply and CRT		
1	6-7-1 Power supply DC level I (voltage range)	6-6	All items
2	6-7-2 Power supply DC level II (ripple voltage)	6-7	All items
3	6-7-3 AC line voltage range	6-8	
4	6-7-4 Limit level	6-9	6-7-5
5	6-7-5 High-voltage power supply	6-10	6-7-6, 6-7-10, 6-9-6, 6-9-11, 6-9-15, 6-11-4 6-11-5, 6-12-1
6	6-7-6 Intensity	6-11	6-7-7
7	6-7-7 Focus	6-12	
8	6-7-8 The parallel of the horizontal trace and horizontal scale (TRACE ROTATION)	6-13	
9	6-7-9 The parallel of the vertical trace and vertical scale (ORTHOGONALITY)	6-14	
10	6-7-10 Pattern distortion	6-15	6-9-6, 6-11-4, 6-11-5
	Calibrator output		
11	6-8-1 Repetition rate	6-16	
12	6-8-2 Output voltage	6-17	
	Vertical deflection system		
13	6-9-1 ADD balance	6-18	6-9-8
14	6-9-2 X5 balance	6-18	6-9-4, 6-10-2, 6-12-2
15	6-9-3 5mV balance	6-19	
16	6-9-4 VARIABLE balance	6-19	6-10-2, 6-12-2
17	6-9-5 Pulse response I (CH1. CH2 sag at 10mV/div)	6-20	
18	6-9-6 Deflection factor I (CH1. CH2)	6-21	6-12-1
19	6-9-7 Pulse response II (CH1. CH2 sag at 1mV/div)	6-23	
20	6-9-8 Position center (CH3. CH4)	6-24	
21	6-9-9 Attenuator compensation I (CH1. CH2)	6-26	

Order	Check and adjustment items	Page	Checks and adjustments affected
21	6-9-9 Attenuator compensation I (CH1. CH2)	6-26	
22	6-9-10 Attenuator compensation II (CH3. CH4)	6-28	
23	6-9-11 Deflection factor II (CH3. CH4)	6-30	
24	6-9-12 Pulse response III (overshoot and others)	6-31	6-9-6, 6-9-13, 6-10-1 to 6-10-3
25	6-9-13 Pulse response IV (CH3・CH4 sag)	6-33	
26	6-9-14 Bandwidth	6-34	
27	6-9-15 Linearity	6-35	
	Trigger system		
28	6-10-1 FIX Triggering level	6-36	
29	6-10-2 Triggering level I (CH1. CH2)	6-38	
30	6-10-3 Triggering level II (CH3. CH4)	6-40	6-9-8
	Horizontal deflection system		
31	6-11-1 Average voltage of horizontal amplifier	6-42	
32	6-11-2 Magnification Center	6-42	6-12-2
33	6-11-3 A.B sweep start	6-43	
34	6-11-4 Sweep rate	6-44	
35	6-11-5 Magnifier sweep rate	6-46	
36	6-11-6 Start and stop of delay	6-47	
37	6-11-7 Jitter X-Y operate	6-49	
	X — Y operation		
38	6-12-1 Deflection factor	6-50	
39	6-12-2 Spot location	6-50	
40	6-12-3 Phase difference	6-51	

6-6 PREPARATION

Before making check and adjustment, prepare the following:

1. Set the ambient temperature at 23° C± 5° C.
2. Before turning the power on, set the switches and control knobs as shown in the table at the left.

Precaution

Open the page to the left and refer to the contents when making check and adjustment of each item.

Switches and controls	Setting
POWER	OFF
A INTEN	Slightly right of the midrange
B INTEN	Midrange
FOCUS	Midrange
SCALE	Full clockwise turn
VERTICAL MODE	CH 1
↕ POSITION (CH 1 • CH 2)	Midrange
VOLTS/DIV (CH 1•2)	10 mV
VARIABLE (CH 1 • 2)	CAL (Push)
AC-DC (CH 1•CH 2)	DC
BAND WIDTH	FULL
CH 2 POLAR	NORM
←→POSITION	Midrange
FINE (PULL X 10 MAG)	Midrange (Push)
COUPLING (A • B)	AC
SOURCE (A • B)	CH 1
HOLDOFF	NORM
HORIZONTAL MODE	AUTO
LEVEL (A•B)	Midrange (push)
A TIME/DIV	1m SEC
A VARIABLE	CAL
HORIZ DISPLAY	A
DELAY TIME MULT	Full counter-clockwise turn

3. Set the voltage switch on the rear panel to meet the line voltage. Connect the power cord to the plug socket of the line. If the line voltage is outside the operating range of SS-5711, set the voltage within the range using a voltage regulator.
4. Turn POWER switch on to supply power, adjust A INTEN to provide the proper intensity and trace, and keep the condition for about 30 minutes to warm up the machine.

6-7 POWER SUPPLY AND CRT CHECK AND ADJUSTMENT

6-7-1 Power Supply DC Level I (Voltage Range)

Item	Description
Rating	

DC power voltage	Output voltage range
− 12 V	Within ± 0.12 V
+ 5 V	Within ± 0.25 V
+ 12 V	Within ± 0.3 V
+ 39 V	Within ± 1.2 V
+129 V	Within ± 3.9 V

Check and Adjustment	Measure the voltage across the measurement position (see figure 6-7-3) and the ground and the ground and check that the values is within the rated values. If the voltage is outside the rated value, adjust "−12V" with 21R 77 −12V ADJ (see figure 6-7-3). Check voltages at other locations again. Note: The design is such that by adjusting −12V, other voltages can be set within the specification range.
Related Items	All items

6-7-2 Power Supply DC Level II (Ripple Voltage)

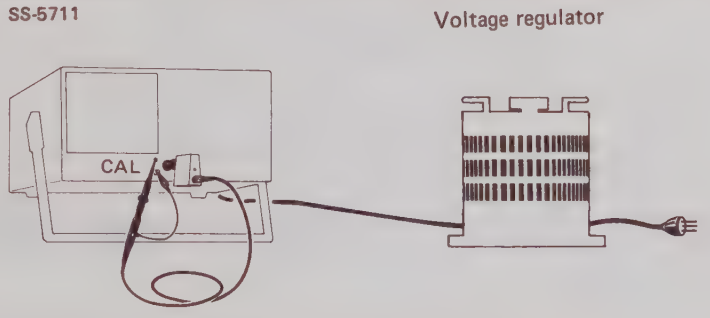
Item	Description
Rating	<table><tr><th>DC power voltage</th><th>Ripple voltage</th></tr><tr><td>– 12 V</td><td>0.5 mVp-p or less</td></tr><tr><td>+ 5 V</td><td rowspan="2">1 mVp-p or less</td></tr><tr><td>+ 12 V</td></tr><tr><td>+ 39 V</td><td rowspan="2">2 mVp-p or less</td></tr><tr><td>+ 129 V</td></tr></table>
Setting	Stop the sweep by setting HORIZ mode to SINGLE.
Check	Connect a X 1 probe the oscilloscope and check the ripple voltages of each power supply.
Related Items	All items

6-7-3 AC Line Voltage Range

Item	Description
Rating	The CRT waveform must be sufficiently stable within the voltage range shown in the right table.

Set position	Center voltage	Voltage range	Fuse used
A	100 V	90 to 110 V	2 A slow-blown fuse
B	115 V	103 to 128 V	
C	220 V	195 to 242 V	1A slow-blown fuse
D	230/240 V	207 to 264 V	

Connection



Setting

With A TIME/DIV switch being set to 10 ms, swing the amplitude 6 div.

Check

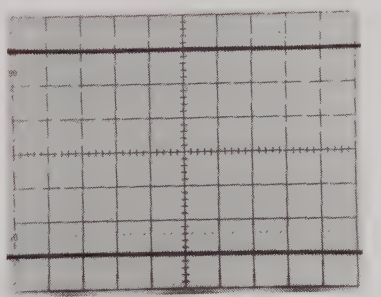
Precaution

In exchange of the power switching plug or replacing fuses, remove the power cord from the line plug socket. When exchanging the voltage plug, remove the rear panel.

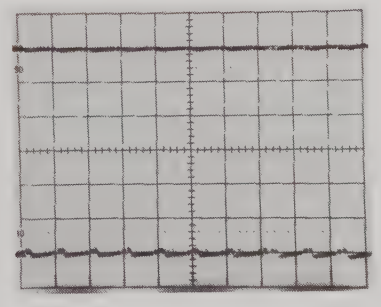
Using a voltage regulator, change the AC supply voltage continuously in the rated range, and check that ripple or intensity modulation does not appear on the CRT waveform.

CRT waveform

Normal waveform



Abnormal waveform



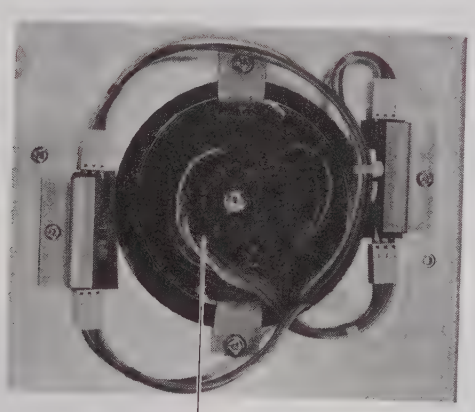
6-7-4 Limiter Level

Item	Description
Rating	The CRT circuit oscillates and stops intermittently when the CRT cathode voltage (−2.45 kV) reaches −2.6 kV to −3.0 kV. In this condition, brightness is increased intermittently and returns to normal when the CRT cathode voltage is restored to −2.45 kV.
Setting	Set A INTEN to fully counter-clockwise.
Check and adjustment	*Precuation* • *The limiter protects the CRT should the high-voltage reach an abnormally high level. The limiter level is checked by altering the CRT cathode voltage (the CRT deflection factor changes when this voltage is aftered). This check should only be performed to check limiter operation or adjust CRT cathode voltage.* • *As high-voltage is measured when the limiter level and CRT cathode voltage (described later) are checked, particular care should be taken to guard against electric shock.* *These checks should be performed only after A INTEN is turned fully to the left to extinguish the trace.* Measure the voltage between the CRT cathode (see Figure. 6-7-1) and GND with a digital multimeter (use a high voltage probe) and gradually raise the voltage with 20R13 HV ADJ (see Figure. 6-7-3). Check that the limiter operates (as evidenced by the intermittent increases in brightness) when the voltage indicated on the multimeter is between −2.6 kV and −3.0 kV. When the above checks have been completed, check the CRT cathode voltage as described in "CRT Cathode Voltage" and set it to −2.45 kV.

6-7-5 High-Voltage Power Supply

Item	Description
Rating	−2.45 kV ±5% (between the CRT cathode and ground)
Check and Adjustment	*Precuation* *If the error of the CRT cathode voltage is within± 5%, do not made adustment, except when all items or deflection factor and sweep rate are adjusted.* Using a digital multimeter (with a high-voltage probe), measure the voltage between the CRT cathode and the ground (see Figure 6-7-1), and check that the voltage is within −2.45 kV ± 5%. If the result is outside the rated value, adjust the voltage with 20 R13 HV ADJ (see Figure 6-7-2).
Related Items	6-7-6, 6-7-10, 6-9-6, 6-9-11, 6-9-15, 6-11-4, 6-11-5, 6-12-1

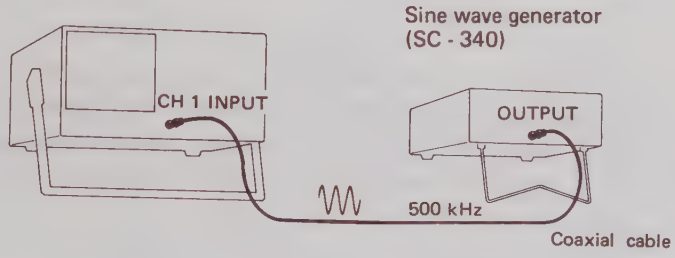
Figure 6-7-1. Testpoint Location (CATHODE of CRT)



6-7-6 Intensity

Item	Description
Rating	The trace is extinguished when A INTEN control is turned fully counter-clockwise.
Setting	Measure the voltage of 19R54 (see Figure 6-7-2) and the ground using the test oscilloscope.
Check and adjustment	Check that the maximum value of the Z AMP output waveform is +80 V when A INTEN control is turned fully clockwise. If it is not +80 V, adjust with 19R31 LEVEL (see Figure 6-7-2). Adjust with A INTEN control so that the maximum value of the Z AMP output is +40 V . The trace should appear faintly at this setting, if it does not, adjust with 20R44 INTEN ADJ (see Figure 6-7-2).
Related Items	6-7-7

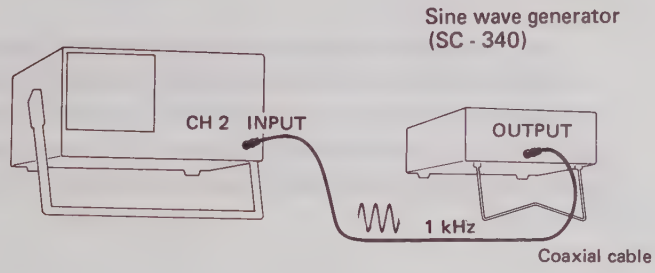
6-7-7 Focus

Item	Description
Rating	Using FOCUS control, adjust focus to a suitable setting within ±45° of midrange.
Connection	SS-5711 
Setting	Set A INTEN control so that the trace is slightly visible, apply a 500 Hz sine wave signal to CH 1 INPUT, and adjust output voltage so that amplitude is 6 divisions.
Check and adjustment	While viewing the waveform, adjust so that the optimum focus is obtained. If optimum focus cannot be obtained, set FOCUS control to the midrange and adjust with ASTIG (on front panel), 20R57 FOCUS 1, and 19R71 FOCUS 2 (see Figure 6-7-2). Adjust with 19R62 AUTO FOCUS (see Figure 6-7-2) to minimize the effect on focus when intensity is adjusted by turning A INTEN control to the right.

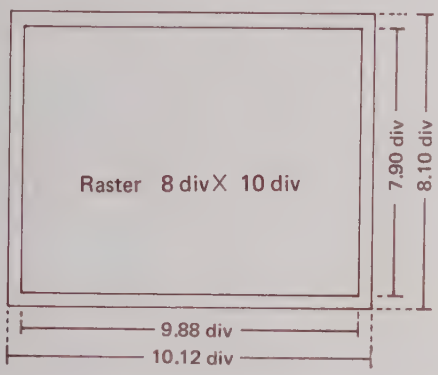
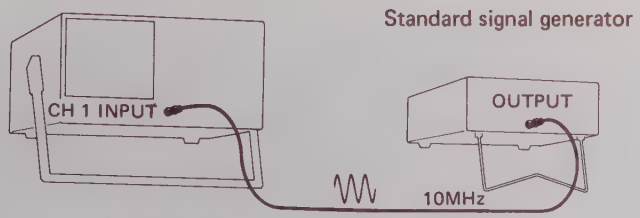
6-7-8 The parallel of the Horizontal Trace and the Horizontal Scale (TRACE ROTATION)

Item	Description
Rating	The horizontal trace and the horizontal scale lines should be parallel at the center of the screen.
Check	*Precaution* *As the angle of the trace is affected to some degree by the earth's magnetism, check and adjust after the SS-5711 is set in position for measurement.* Superimpose the trace on the horizontal center line of the scale (use POSITION control) and check that both are parallel. If they are not parallel, adjust with TRACE ROTATION (on the front panel).

6-7-9 The Parallel of the Vertical Trace and the Vertical Scale (ORTHOGONALITY)

Item	Description
Rating	The vertical trace and vertical scale lines should be parallel at the center of the screen.
Connection	SS-5711 
Setting	Set HORIZONTAL DISPLAY switch to X – Y and adjust to an amplitude of 8 divisions.
Check and adjustment	*Precuation* *As the angle of the trace is affected to some degree by the earth's magnetism, check and adjust after the SS-5711 is set in position for measurement.* Superimpose the trace on the vertical center line of the scale (use POSITION control and FINE control) and check that both are parallel. If they are not parallel, adjust with 18R102 ORTHOGONALITY (see Figure 6-7-2). Note: As the adjustments in 6-7-8 and 6-7-9 affect each other, they should be repeated a number of times.

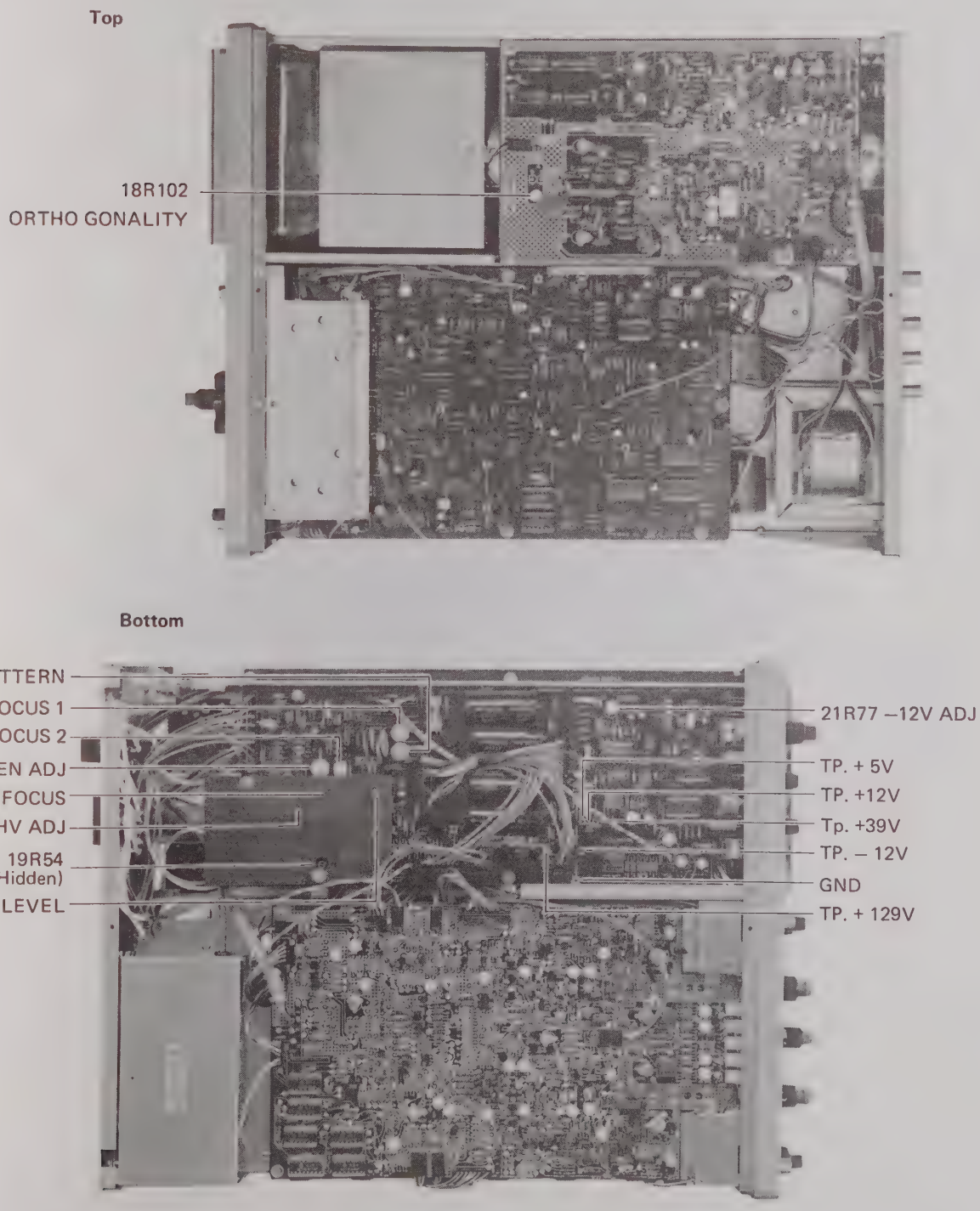
6-7-10 Pattern Distortion

Item	Description
Rating	Produce raster in the range of 8 div X 10 div on the CRT screen , and check that the vertical and horizontal deflection of raster is within the range shown in the figure at the right. 
Connection	SS-5711 
Setting	

SS-5711				Input	Signal	Amplitude on CRT screen
HORIZ DISPLAY	A TIME/DIV	B TIME/DIV	HOLD OFF	Waveform	Frequency	
A INTEN	1 mS	20 nS	B ENDS A	Sine	10 MHz	8 div

Check and adjustment	1. Check the horizontal deflection of raster on the top and bottom of scale. 2. Set the raster to the right and left ends of scale and check the vertical deflection of the raster. If the check result shows a great distortion, adjust it with 20R61 PATTERN (see Figure 6-7-2).
Related Items	6-9-6, 6-11-4, 6-11-5

Figure 6-7-2 Adjustment and testpoint Locations (POWER SUPPLY and CRT)



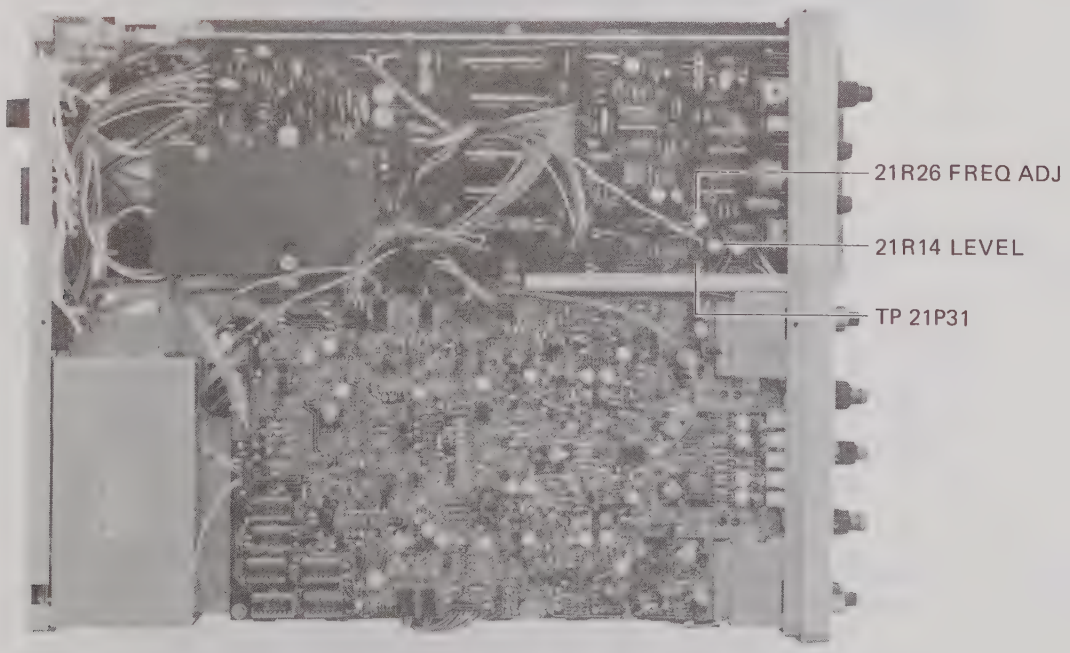
6-8 CALIBRATOR OUTPUT

6-8-1 Output Voltage

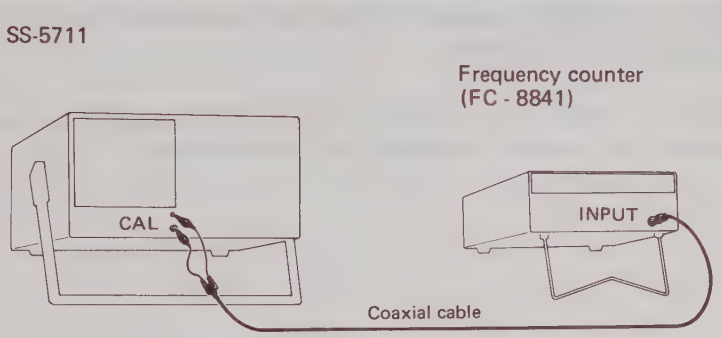
Item	Description
Rating	0.6 V ±1%
Setting	Short test terminals 21 P 31 (see Figure 6-8-1) to stop oscillation.
Check and adjustment	Use a digital multimeter to measure the voltage between the CAL 0.6 V terminal and GND. Check that this voltage is between 0.594 V and 0.606 V and adjust with 21R 14 LEVEL (see 6-8-1), if out of the rating.

Figure 6-8-1 Adjustment Location (CALIBRATOR OUTPUT)

Bottom



6-8-2 Repetition Rate

Item	Description
Rating	1 kHz ±1%
Connection	
Check	Check that the calculated value is within 1 kHz ±1%. If it is not, adjust with 21R26 FREQ ADJ (see Figure 6-8-1).

6-9 VERTICAL DEFLECTION SYSTEM

6-9-1 ADD Balance

Item	Description
Setting	Set the vertical MODE switch to ALT and set the horizontal traces to the center of the screen with CH1 and CH2 POSITION control.
Check and adjustment	Turn the vertical MODE switch to ADD and check that the trace does not move. Adjust with 8R31 ADD BAL (see Figure 6-9-1), if it does move.
Related Items	6-9-8

6-9-2 X 5 Balance

Item	Description
Setting	Set the CH1 and CH2 VOLTS/DIV switches to 5 mV.
Check and adjustment	Check that the trace does not move when PULL X 5 MAG switch is replaced by push-pull. If CH1 moves, adjust with 1R46 X 5 BAL (see Figure 6-9-1), and if CH2 moves, adjust with 2R46 X 5 BAL (see Figure 6-9-1).
Related Items	6-9-4, 6-10-2, 6-12-2

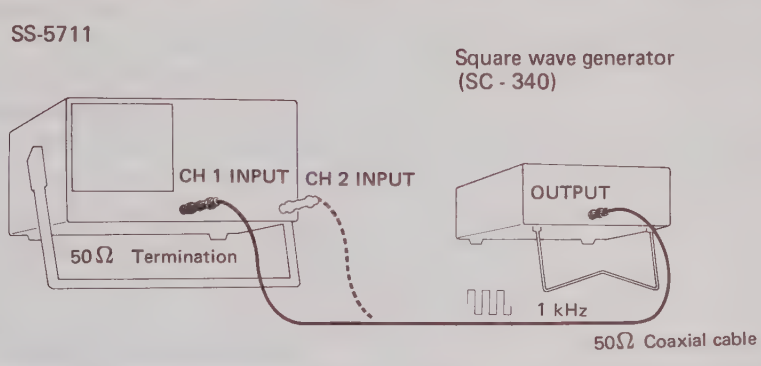
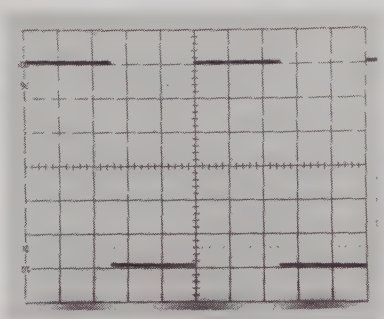
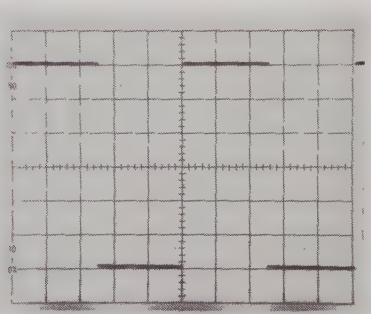
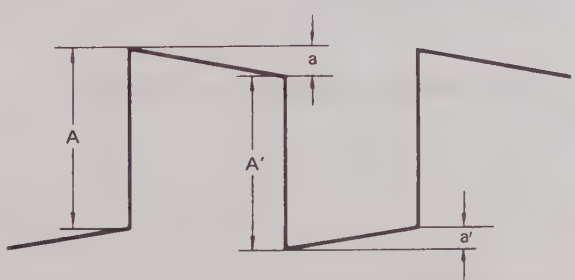
6-9-3 5 mV Balance

Item	Description
Check and adjustment	Check that the trace does not move when the VOLTS/DIV switch setting turned from 10 mV/DIV to 5 mV/DIV. If CH1 moves, adjust with 1R77 5 mV BAL (see Figure 6-9-1), and if CH2 moves, adjust with 2R77 5mV BAL (see Figure 6-9-1).

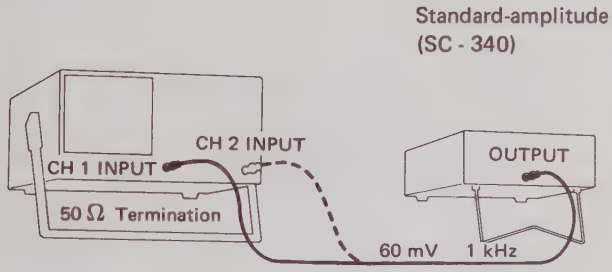
6-9-4 Variable Balance

Item	Description
Check and adjustment	Check that the trace does not move when VARIABLE control is turned. If CH1 moves, adjust with 3R47 VAR BAL (see Figure 6-9-1), and if CH2 moves, adjust with 4R47 VAR BAL (see Figure 6-9-1). Perform the same check with VOLTS/DIV switch set to 5 mV, 2 mV and 1 mV.
Related Items	6-10-2, 6-12-2

6-9-5 Pulse Response I (CH1 · CH2 sag at 10 mV/DIV)

Item	Description
Rating	1%
Connection	
Setting	Set to an amplitude of 8 divisions on the CRT screen.
Check and Adjustment	Check flatness of the square wave. If CH1 is out of the rating adjust with 1R63 X 1 LF COMP (see Figure 6-9-1), and if CH2 is not within the rated value, adjust with 2R63 X1 LF COMP (see Figure 6-9-1).
CRT waveform	60Hz  1kHz 
Reference	 A: Basic amplitude Sag = $\frac{a}{A}$ (or $\frac{a'}{A'}$) x 100% a: Sag The larger or $\frac{a}{A}$ or $\frac{a'}{A'}$ is taken. (Electronic Machinery Industry Association MEA - 27)

6-9-6 Deflection Factor I (CH1·CH2)

Item	Description
Rating	X 1: ±2% X 5: ±4%
Connection	SS-5711 
Setting	

Sequence	SS-5711		Input voltage	Amplitude on CRT screen	Calibrator	
	Channel	VOLTS/DIV			Circuit No.	Name
1	CH1•CH2	10 mV	60 mV	–	8R64 *1	MAIN GAIN
	CH1			6 div ±2%	3R56	CH1 GAIN
	CH2				4R56	CH2 GAIN
2	CH1	5 mV	30 mV		3R32	CH1 5 mV GAIN
	CH2				4R32	CH2 5 mV GAIN
3	CH1•CH2	5 mV *2	6 mV	6 div ±4%	–	–
		10 mV *2	12 mV			
		20 mV	120 mV	6 div ±2%		
		50 mV	0.3 V			
		0.1 V	0.6 V			
		0.2 V	1.2 V			
		0.5 V	3 V			
		1 V	6 V			
		2 V	12 V			
		5 V	30 V			

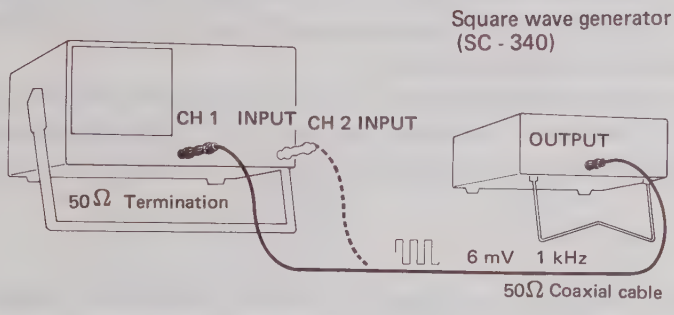
*1 Coarse adjustment for CH1 and CH2, used with large errors in the same direction.

*2 (PULL X5 MAG) pulled out

6-9-6 Deflection Factor I (Cont)

Item	Description
Check and adjustment	1. Check amplitude at 10 mV/div. a. If the errors in the CH1 and CH2 ranges large in the same direction, adjust with 8R64 MAIN GAIN (see Figure 6-9-1). b. If the CH1 10 mV range is out of the rating, adjust with 3R 56 CH1 GAIN (see Figure 6-9-1), and if the CH2 10 mV range is out of the rating, adjust with 4R56 CH2 GAIN (see Figure 6-9-1).. 2. Check amplitude at 5 mV/div. If the CH1 5 mV range is out of the rating, adjust with 3R32 CH1 GAIN (see Figure 6-9-1), and if the CH2 5 mV range is out of the rating, adjust with 4R32 CH2 GAIN (see Figure 6-9-1). 3. Check amplitude of other ranges by switching VOLTS/DIV switches and input voltage. Note: The equipment is designed so that the 20 mV and lower ranges are corrected automatically when adjustments 1, 2, and 3 are performed. Large errors in these ranges therefore employ that the values of the resistors in the attenuator have changed.
Related Item	6-12-1

6-9-7 Pulse Response I (CH1 · CH2 sag at 10 mV/div)

Item	Description
Rating	1%
Connection	SS-5711 
Setting	Set to an amplitude of 6 divisions on the CRT screen.
Check and adjustment	Check flatness of the square wave, If CH1 is out of the rating adjust with 1R27 X 5 LF COMP (see Figure 6-9-1), and if CH2 is out of the rating, adjust with 2R27 X 5 LF COMP (see Figure 6-9-1). Check that the amplitude on the screen is 6 div ±1.8 div, if it exceeds this range, and adjust as in 6-9-6.
CRT waveform	See Figure 6-9-5. (page 6-21)
Reference	See Figure 6-9-5. (page 6-21)

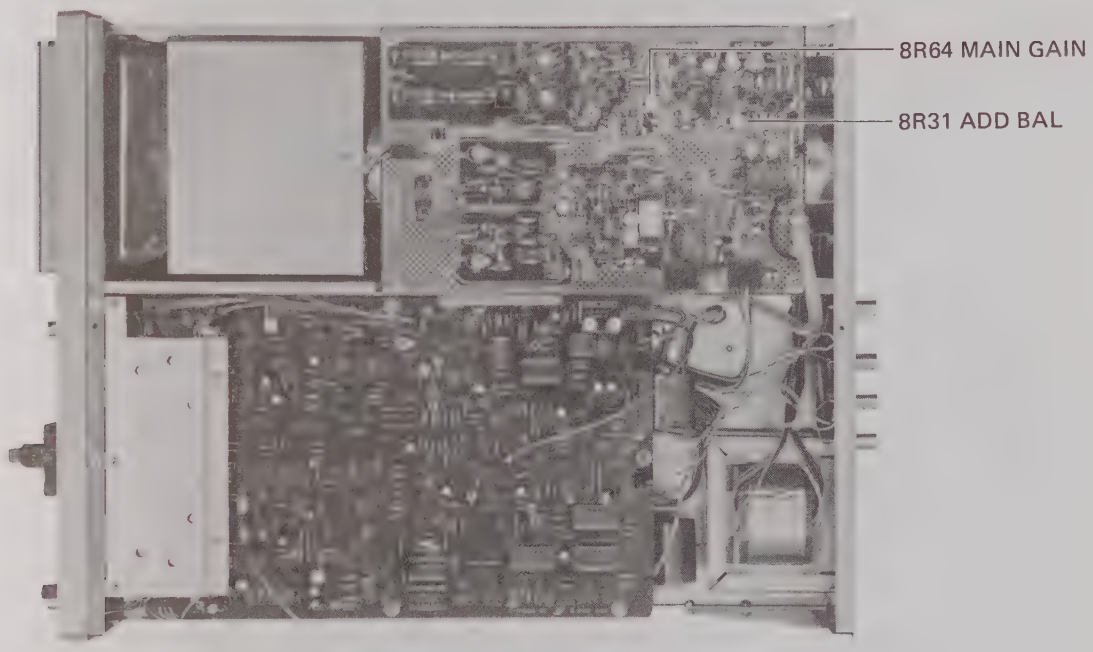
6-9-8 Position Center (CH3·CH4)

Item	Description
Setting	Set ALT and QUAD of vert MODE to IN (push).
Check and adjustment	*Precaution* *Adjust following "Check and Adjustment of triggering" (described later).* Set CH3 and CH4 to their center positions and check that the CH3 and CH4 traces are one division below the horizontal centeriline, If the CH3 trace is not one division below the horizontal centerline, adjust with 5R36 CH3 POS (see Figure 6-9-1), and if the CH4 trace is not one division below the horizontal centerline, adjust with 5R56 CH4 POS (see Figure 6-9-1).

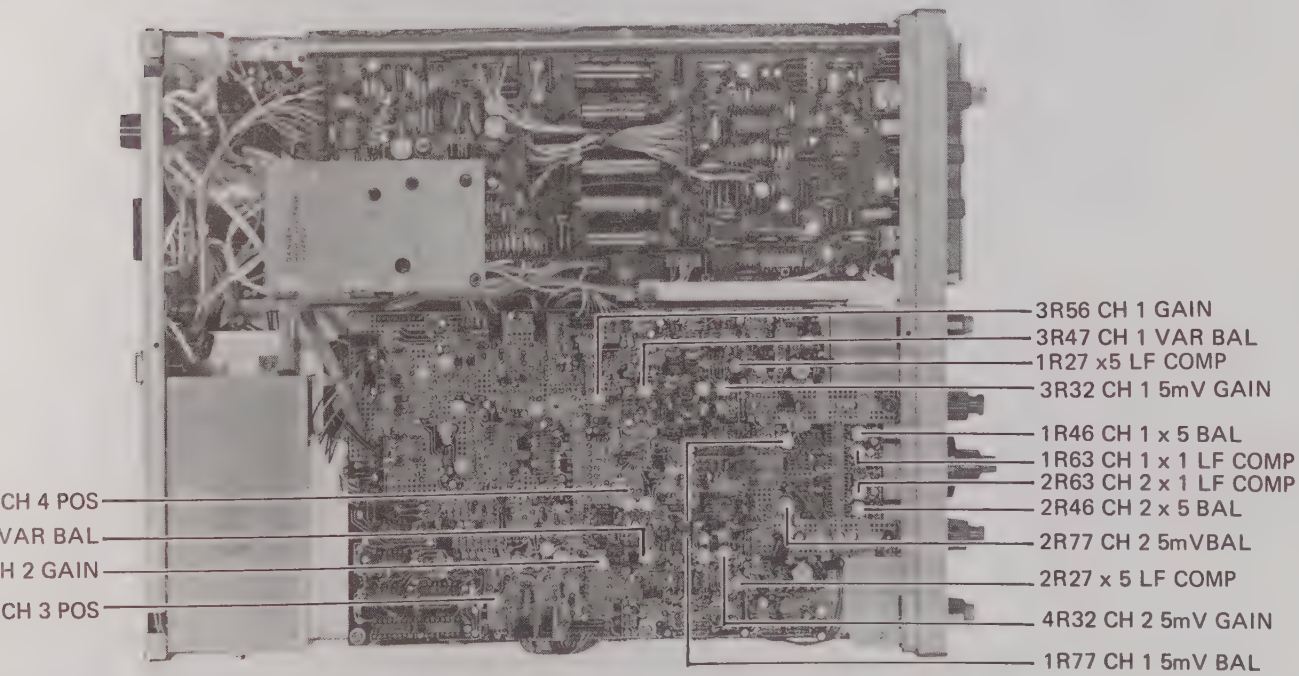
5R5
4R47 CH
4R56
5R3

Figure 6-9-1. Adjustment locations (VERTICAL DEFLECTION SYSTEM 1)

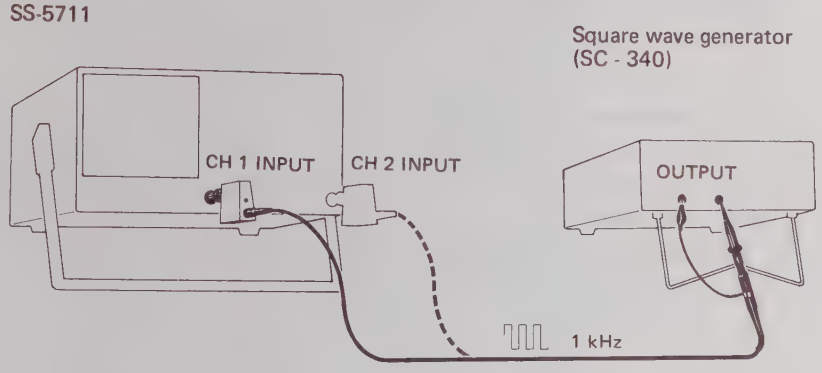
Top



Bottom


3R56 CH 1 GAIN
3R47 CH 1 VAR BAL
1R27 x5 LF COMP
3R32 CH 1 5mV GAIN
1R46 CH 1 x 5 BAL
1R63 CH 1 x 1 LF COMP
2R63 CH 2 x 1 LF COMP
2R46 CH 2 x 5 BAL
2R77 CH 2 5mVBAL
2R27 x 5 LF COMP
4R32 CH 2 5mV GAIN
1R77 CH 1 5mV BAL
CH 4 POS
VAR BAL
H 2 GAIN
CH 3 POS

6-9-9 Attenuator Compensation I (CH1·CH2)

Item	Description
Rating	1% or less
Connection	
Setting	

Sequence	SS-5711	Input signal			Amplitude on screen	Calibrator
	Channel	Voltage	Waveform	Frequency		Circuit No.
1	CH 2	0.6 V	Square wave	1 kHz	6 div	* 1
2	CH 2					1C11
3	CH 1 ·CH 2	Adjust to required VOLTS/DIV value			Easily observable amplitude	* 2

*1. Adjust the phase of the X 10 probe.

*2. The attenuator compensator capacitor is incorporated in the VOLTS/DIV switch. Only the capacitor used to adjust the set VOLTS/DIV switch is visible externally (see Figure 6-9-2).

Check and adjustment

1. Check the flatness of the CH2 square wave and adjust the compensation of the X 10 probe as required.
2. Check the flatness of the CH1 square wave and adjust 1C11 (see Figure 6-9-2) as required.
3. Turn VOLTS/DIV switch and input voltage and check and adjust the compensation of attenuator (see Figure 6-9-2).

Note: The 5 mV range is for checking only, not for adjustment.

6-9-9 Attenuator Compensation I (CH1 · CH2) (Cont.)

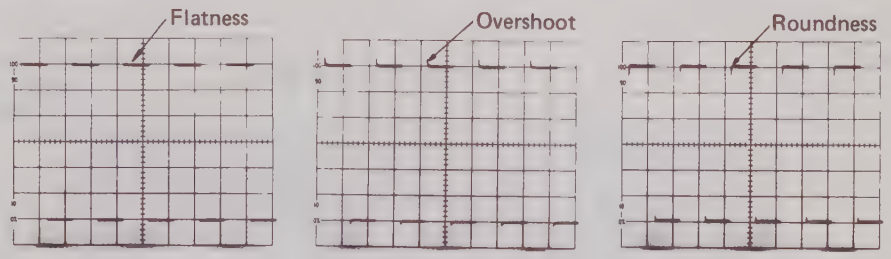
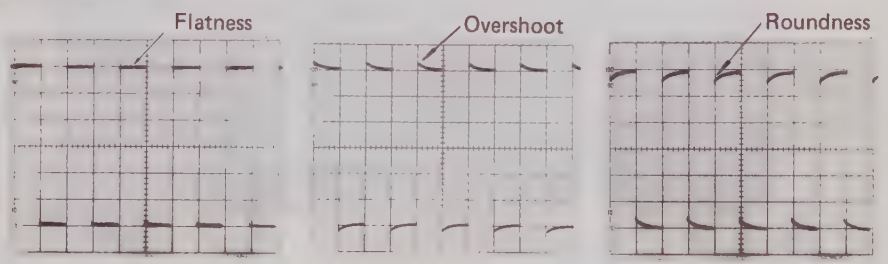
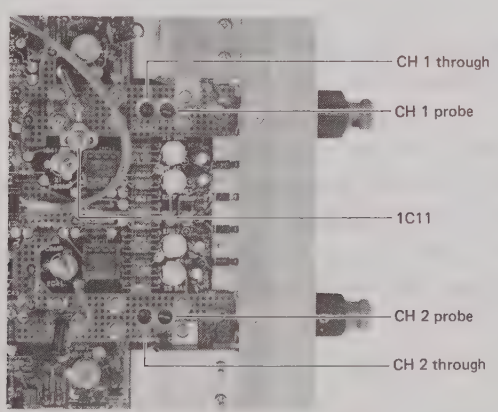
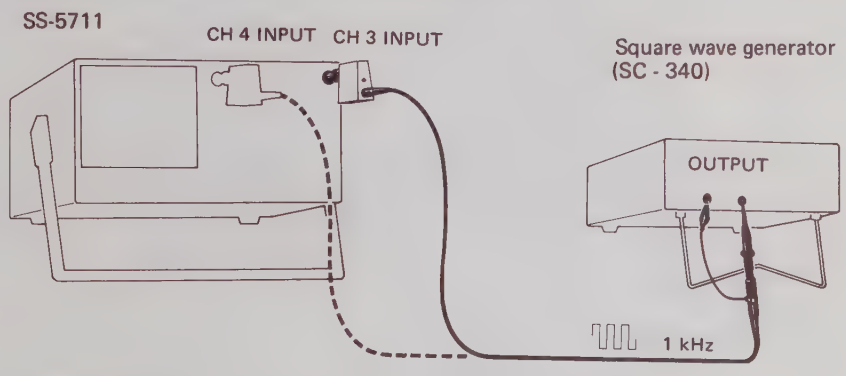
Item	Description
CRT waveform	Through compensation  (a) Proper (b) Improper (overcompensation) (c) Improper (undercompensation)
	Probe compensation  (a) Proper (b) Improper (overcompensation) (c) Improper (undercompensation)

Figure 6-9-2. Adjustment locations (CH1 · CH2 attenuator compensation)

Bottom



6-9-10 Attenuator Compensation II (CH3.CH4)

Item	Description
Rating	2% or less
Connection	

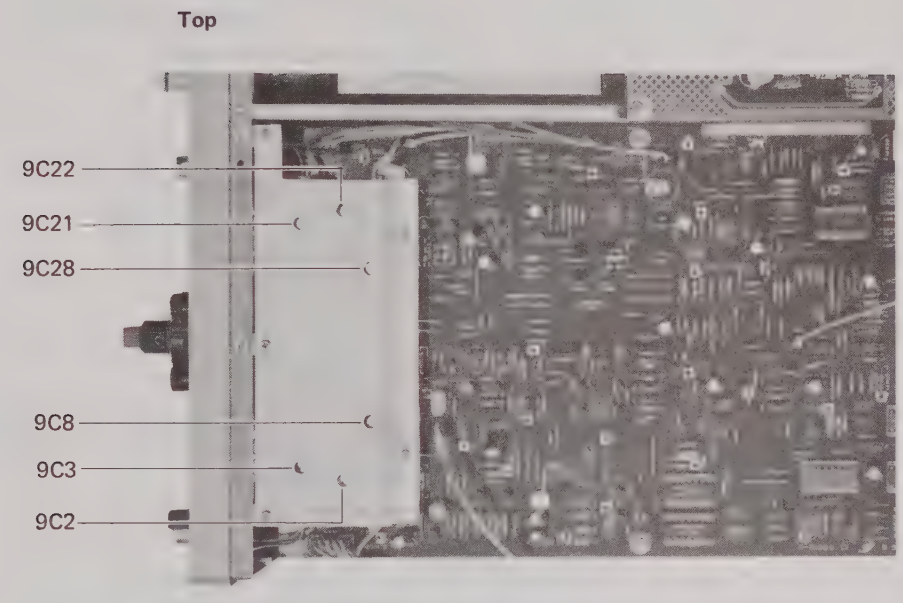
Setting

Frequency	SS-5711			Input Signal			Amplitude on screen	Calibrator	Remark
	Channel	Vert MODE	0.1 V-1 V	Voltage	Waveform	Frequency		Circuit No.	
1	CH 3	ALT and QUAD IN push	0.1 V	6 V	Square wave	1 kHz	6 div ±2%	9 C8 and probe	—
2			1 V	60 V				9 C2	Probe
								9 C3	Through
3	CH 4		0.1 V	6 V				9 C28 and probe	—
4			1 V	60 V				9 C22	Probe
								9 C21	Through

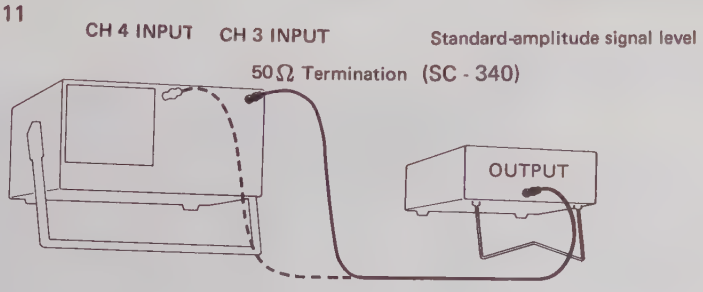
Check and adjustment

1. Check flatness of the CH3 square wave. Adjsut with 9C8 (see Figure 6-9-3) and the probe compensation adjustment variable capacitor as required.
2. Set 0.1V – 1V switch to 1 V, set the input signal to 60 V, and check the attenuator compensation. Adjust with 9C3 and 9C2 (see Figure 6-9-3) as required.
3. Check flatness of the CH4 square wave. Adjust with 9C28 (see Figure 6-9-3) and the probe compensation adjustment variable capacitor as required.
4. Set 0.1 – 1 V switch to 1 V, set the input signal to 60 V, and check the attenuator compensation. Adjust with 9C21 and 9C23 (see Figure 6-9-3) as required.

Figure 6-9-3. Adjustment locations (CH3 • CH4 attenuator compensation)



6-9-11 Deflection Factor II (CH3· CH4)

Item	Description
Rating	±4% or less
Connection	
Setting	

SS-5711			Input signal			Amplitude on screen	Calibrator	
Channel	Vert MODE	0.1 V – 1 V	Voltage	Wave-form	Fre-quency		Circuit No.	Name
CH3	ALT and QUAD IN (push)	0.1 V	0.6 V	sine	1 kHz	6 div ±4%	5R33	CH3 GAIN
		1 V	6 V				–	–
CH4		0.1 V	0.6 V				5R53	CH4 GAIN
		1 V	6 V				–	–

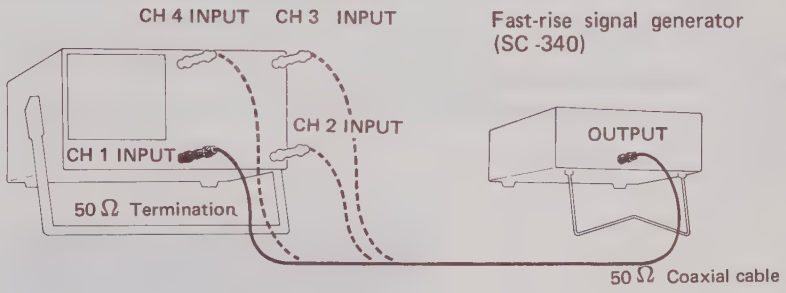
Check and adjustment	Check that the amplitude on the CRT screen is within 6 div. ±4%. If the CH3 is out of the rating adjust with 5R33 CH3 GAIN (see Figure. 6-9-4), and if the CH4 is out the rating, adjust with 5R53 CH4 GAIN (see Figure. 6-9-4).

6-9-12 Pulse Response III (overshoot and others)

Item	Description		
Rating	CH1 CH2	Overshoot	3% or less
		Other waveform distortion	3% or less
	CH3 CH4	Overshoot	7% or less
		Other waveform distortion	5% or less

Connection

SS-5711



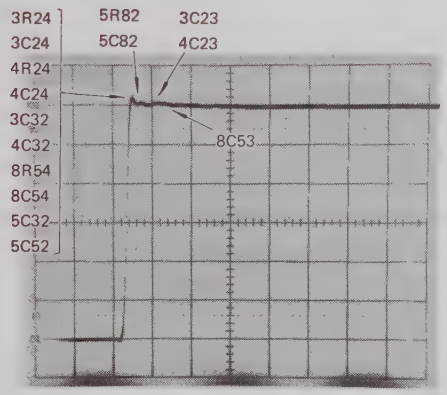
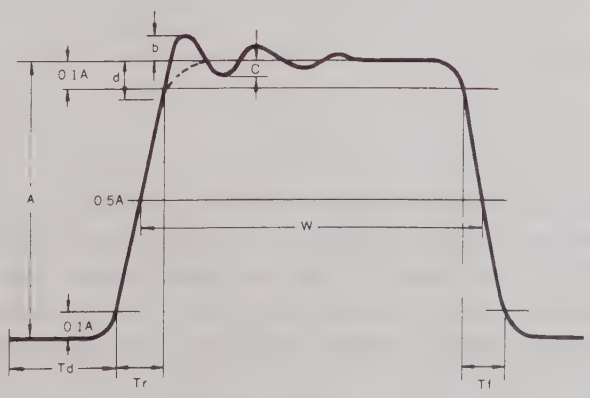
Setting

Se-quence	SS-5711 Channel	SS-5711 VOLTS/DIV	Input signal Voltage	Input signal Fre-quency	Ampli-tude on screen	Calibrator circuit No. Sparate	Calibrator circuit No. Common
1	CH1	10 mV	60 mV	100 KHz	6 div	3R24, 3C23, 3C24	5R82
	CH2					4R24, 4C23, 4C24	8R54
2	CH1	5 mV	30 mV			3C32	8C53
	CH2					4C32	8C54
3	CH3	0.1V	0.6V			5C32	5C82
	CH4					5C52	

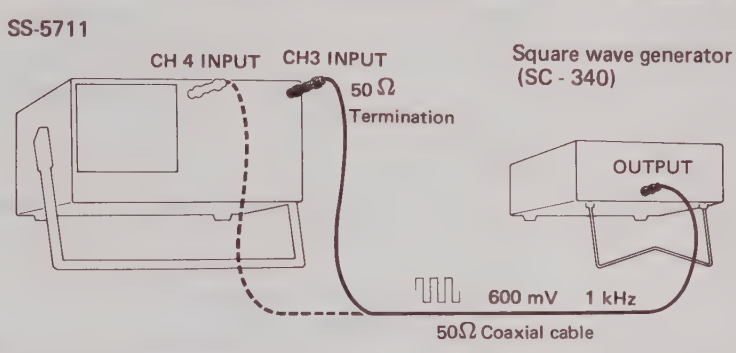
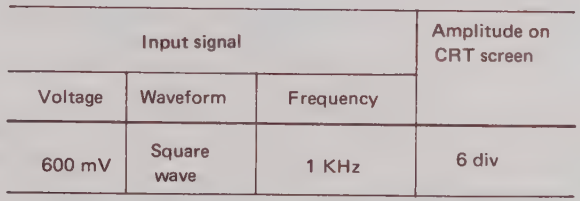
Check and adjustment

1. Check CH1 and CH2 overshoot and other distortion. If CH1 is out of the rating, adjust with 3R24,3C23, 3C24 (see Figure. 6-9-4) and the common calibrators (see Figure.6-9-4), if CH2 is out of the rating, adjust with 4R24, 4C23, 4C24 (see Figure 6-9-4) and the common calibrators (see Figure 6-9-4).
2. Turn VOLTS/DIV switch to 5 mV and check as above. If CH1 is out of the rating, adjust with 3C32 (see Figure. 6-9-4) and the common calibrators, if CH2 is out of the rating, adjust with 4C32 (see Figure. 6-9-4) and the common calibrators.

6-9-12 Pulse Response III (Cont)

Item	Description
	3. Check CH3 and CH4 overshoot and other distortion. If CH3 is out of the rating, adjust with 5C32 (see Figure 6-9-4) and the common calibrators, if CH4 is out of the rating, adjust with 5C52 (see Figure. 6-9-4) and the common calibrators. *Precuation* *When adjusting, check as in "Bandwidth" (described later).*
Related Items	6-9-6, 6-9-13, 6-10-1 to 6-10-3
CRT waveform	
Reference	 A: Basic amplitude b/A: Overshoot c/A: Ringing W: Pulsewidth Tr: Right time Tf: Fall time d/A: Rounding Td: Signal delay time

6-9-13 Pulse Response IV (CH3· CH4 sag)

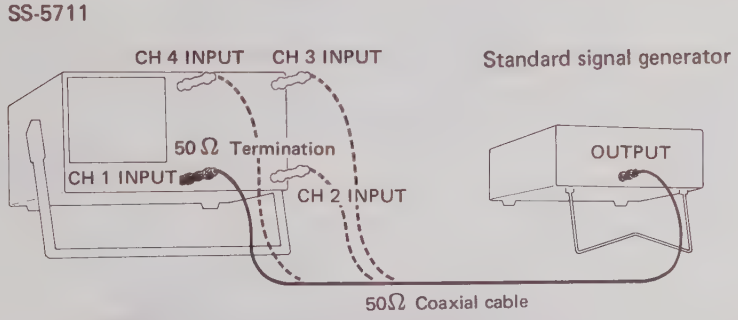
Item	Description
Rating	2%
Connection	
Setting	
Check	Set the waveform at the center of the screen and check sags of CH3 and CH4
CRT waveform	See 6-9-5 (page 6-21)

Input signal			Amplitude on CRT screen
Voltage	Waveform	Frequency	
600 mV	Square wave	1 KHz	6 div

6-9-14 Bandwidth

Item	Description			
Rating	CH1 CH2	5 mV/div to 2V/div	DC to 100MHz	–3dB
		1mV/div, 2mV/div	DC to 50MHz	–3dB
		5V/div	DC to 100MHz	–3.5dB
	CH3 CH4	0.1V/div	DC to 100MHz	–3dB
		1V/div	DC to 100MHz	–3.5dB

Connection



Setting

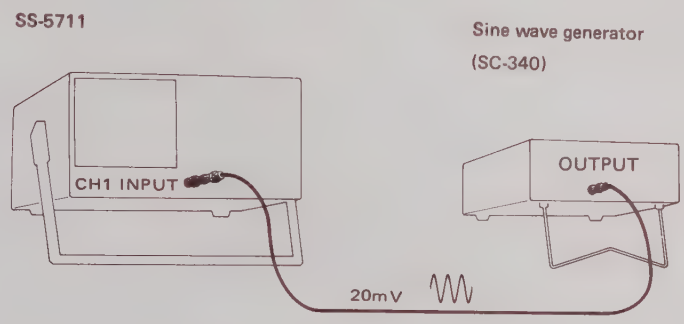
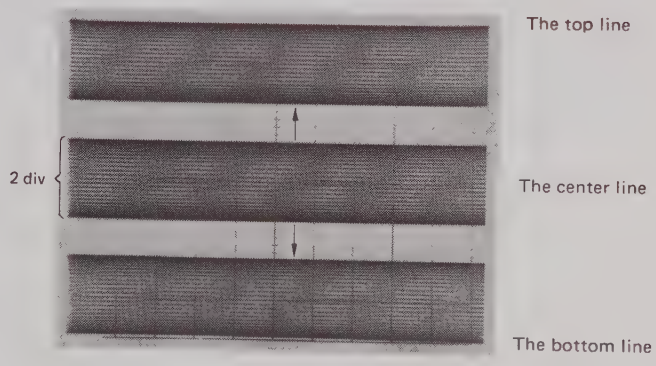
Se-quence	SS-5711		Input signal			Amplitude on CRT screen
	Channel	VOLTS/DIV	Voltage	Wave-form	Frequency	
1	CH1・CH2	5 mV	30 mV	sine	50 kHz	6 div
2					100 MHz	4.25 div or more
1		1 mV	6 mV		50 kHz	6 div
2					50 MHz	4.25 div or more
1		5 V	30 V		50 kHz	6 div
2					100 MHz	4.01 div or more
1	CH3・CH4	0.1 V	0.6 V		50 kHz	6 div
2					100 MHz	4.25 div or more
1		1 V	6 V		50 kHz	6 div
2					100 MHz	4.01 div or more

Check

1. Set the reference frequency to 50 kHz and adjust the signal generator so that the amplitude swings 6 div.
2. Then, change the frequency corresponding to each rating, and read the amplitude.

If the bandwidth is outside the rated values, readjust the items of "Square Wave Response" described previously. In this case, rise the tip of waveform sharply in order to have a good bandwidth.

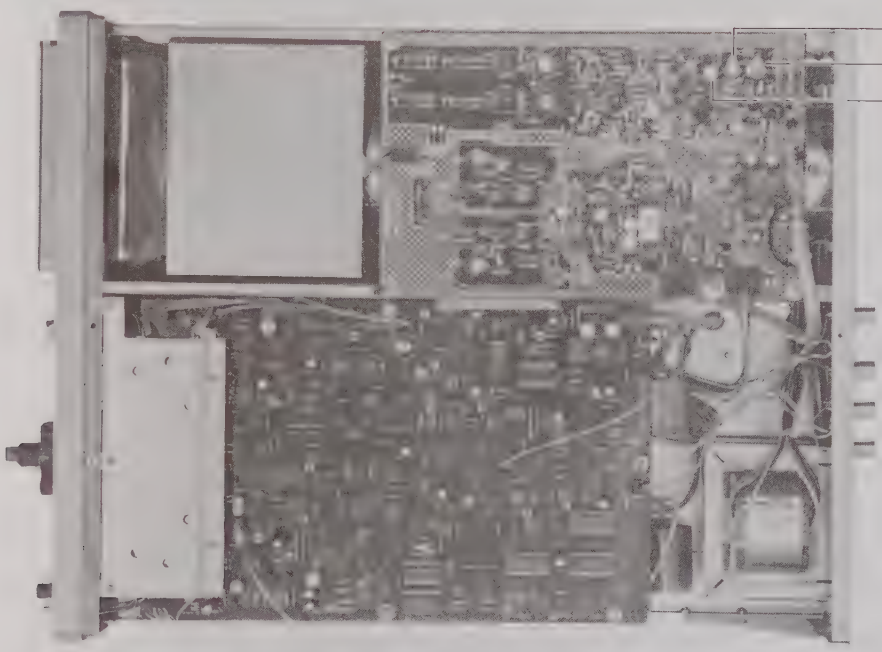
6-9-15 Linearity

Item	Description
Rating	Within ± 3% (at 1 kHz)
Connection	
Settng	
Check	Swing amplitude by 2 div at the screen center. Then using POSITION control, move the waveform within 2 div at the top and bottom of the scale, and check that the amplitude chang is within ± 3%.
CRT Waveform	

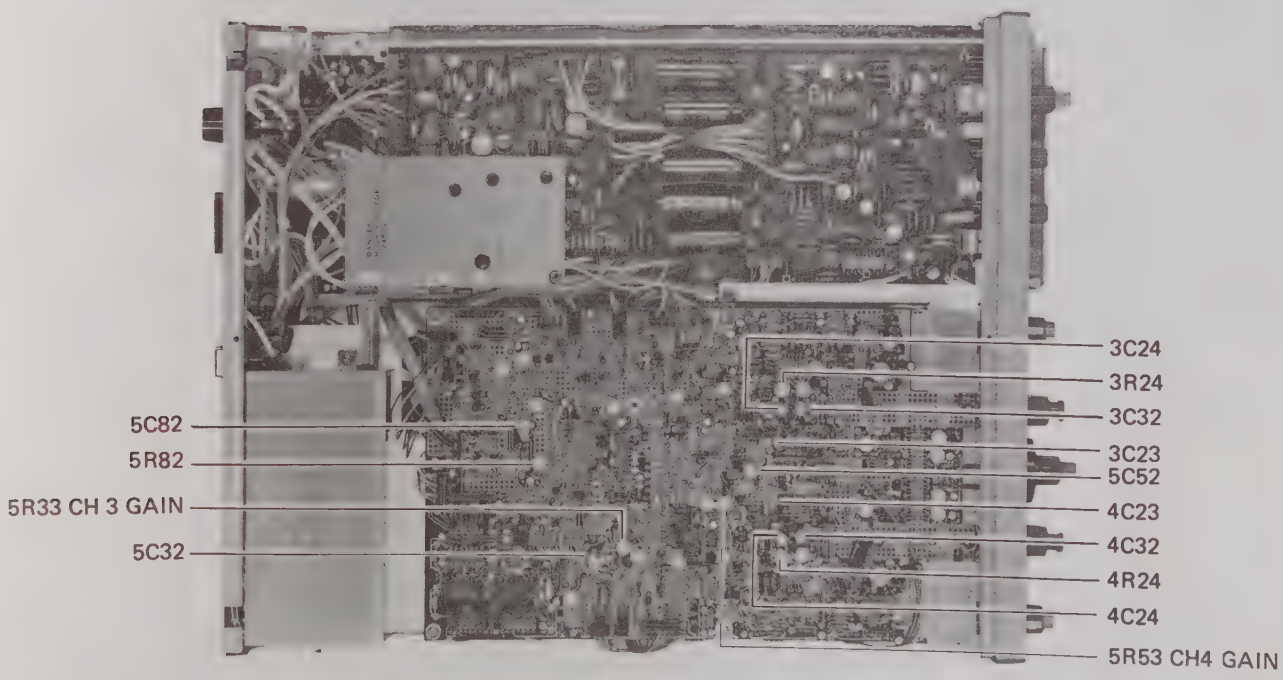
SS-5711	Input signal			Amplitude on CRT screen
Channel	Voltage	Waveform	Frequency	
CH1 • CH2	20 mV	Sine	1 kHz	2 div

Figure 6-9-4. Adjustment locations (VERTICAL DEFLECTION SYSTEM II)

Top



Bottom



6-10 TRIGGERING SYSTEM

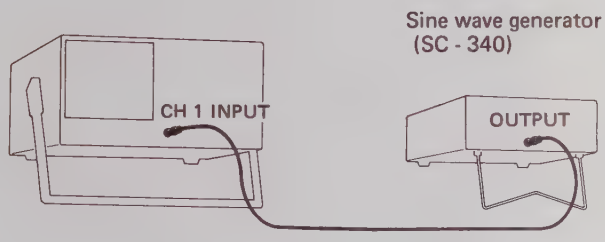
6-10-1 FIX triggering level

Item

Connection

Description

SS-5711



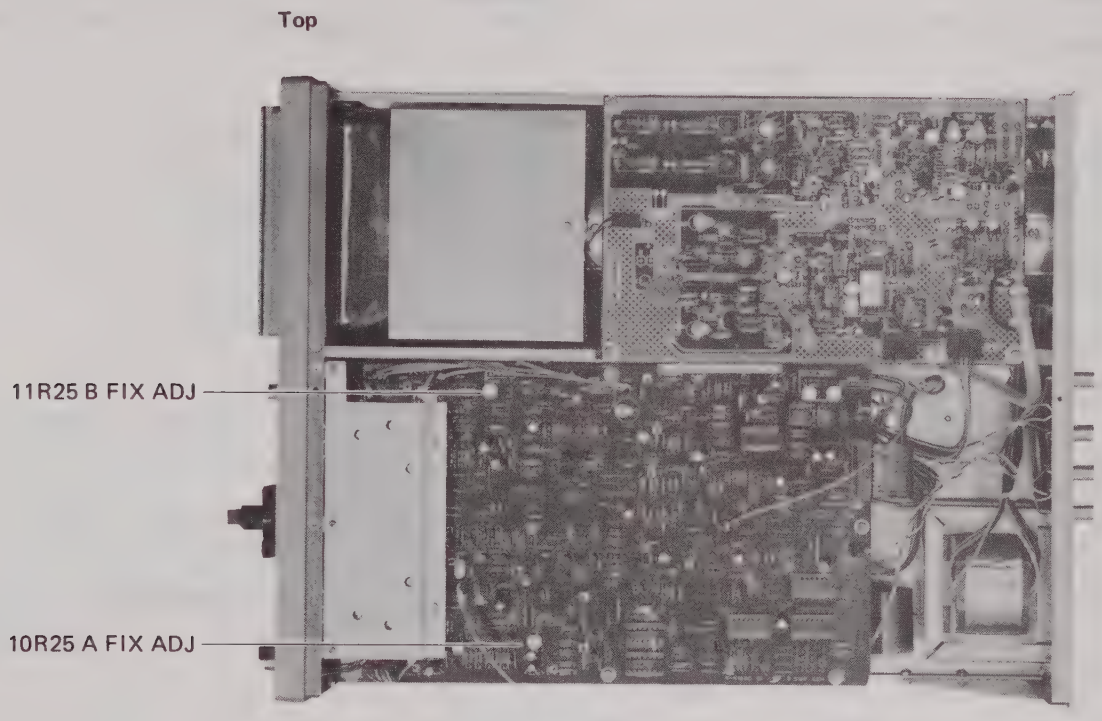
Setting

Sequence	SS-5711					Input signal			Amplitude on screen	Calibrator	
	Vert MODE	VOLTS/ DIV	A coupling	B coupling	HORIZ DISPLAY	Voltage	Waveform	Frequency		Circuit No.	Name
1	CH1	0.1 V	FIX	–	A	0.4 V	sine	1 kHz	4 div	10R25	FIX ADJ
2			–	FIX	B (DLY'D)					11R25	FIX ADJ

Check and adjustment

1. Check that the waveform on the CRT screen is synchronized and that it does not change when A sweep LEVEL control is turned. If the waveform is not synchronized, or is noticeably distant from the horizontal line through the start point, adjust with 10R25 A FIX ADJ (see Figure 6-11-1).
2. Set HORIZ DISPLAY to B (DLY'D) and check that the waveform on the CRT screen is synchronezed and that it does not change when B sweep LEVEL is turned. If the waveform is not synchronized, or is noticeably distant from the horizontal line through the start point, adjust with 11R25 B FIX ADJ (see Figure. 6-10-1).

Figure 6-10-1. Adjustment locations (FIX TRIGGERING LEVEL)



6-10-2 Triggering Level I (CH1・CH2)

Item

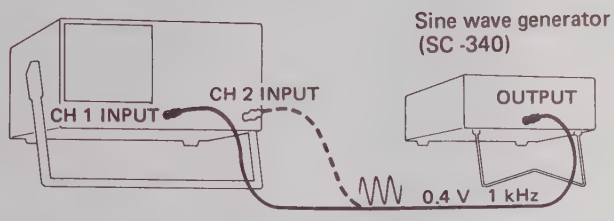
Connection

Setting

Check and adjustment

Description

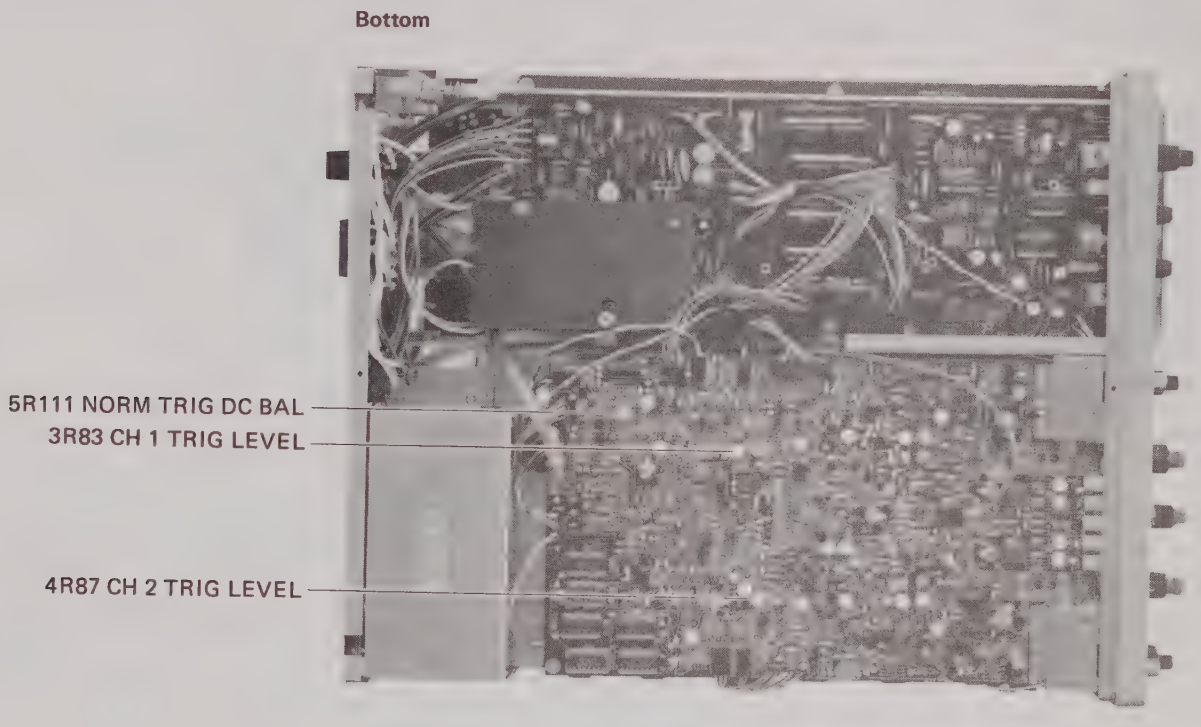
SS-5711



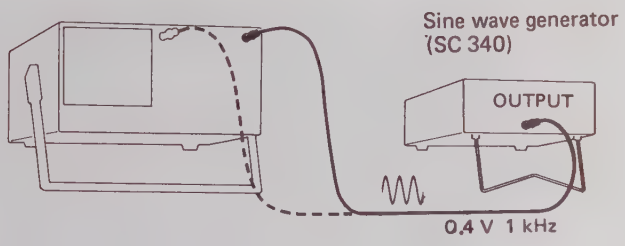
Frequency	Item	SS-5711 Vert MODE	SS-5711 VOLTS/DIV	SS-5711 A・B coupling	SS-5711 A・B source	Input voltage Voltage	Input voltage Waveform	Input voltage Frequency	Amplitude on screen	Calibrator Circuit No.	Calibrator Name
1	A triggering	CH1	0.1V	A DC	A CH1	0.4 V	sine	1 kHz	4 div	3R83	CH1 TRIG LEVEL
1	B triggering	CH1	0.1V	B DC	B CH1	0.4 V	sine	1 kHz	4 div	–	–
2	A triggering	CH1	0.1V	A DC	A NORM	0.4 V	sine	1 kHz	4 div	5R111	NORM TRIG DC BAL
2	A triggering	CH2	0.1V	A DC	A NORM	0.4 V	sine	1 kHz	4 div	–	–
2	A triggering	CH2	0.1V	A DC	A CH2	0.4 V	sine	1 kHz	4 div	4R87	CH2 TRIG LEVEL
3	B triggering	CH2	0.1V	B DC	B CH2	0.4 V	sine	1 kHz	4 div	–	–

1. Check that the triggering level is the middle of the input signal amplitude when A LEVEL control is set to the midrange. If not the middle, adjust with 3R83 CH1 TRIG LEVEL (see Figure. 6-10-2). Perform the same check with B triggering as well.
2. Turn A SOURCE switch to NORM and perform the same check as above. If not the middle, adjust with 5R111 NORM TRIG DC BAL (see Figure. 6-10-2).
3. Turn A SOURCE switch to CH2 and perform the same check as above. If not the middle, adjust with 4R87 CH2 TRIG LEVEL (see Figure 6-10-2). Perform the same check with B triggering as well.

Figure 6-10-2. Adjustment locations (CH1 • CH2 TRIGGERING LEVEL)



6-10-3 Triggering Level II (CH3· CH4)

Item	Description
Connection	SS-5711 CH 4 INPUT CH 3 INPUT 
Setting	

Sequence	Item	SS-5711 Vert MODE	SS-5711 VOLTS/DIV	SS-5711 A・B coupling	SS-5711 A・B source	Input signal Voltage	Input signal Waveform	Input signal Frequency	Amplitude on screen	Calibrator Circuit No.	Calibrator Name
1	A triggering	QUAD CHOP IN (PUSH)	0.1 V	A DC	A CH3	0.4 V	sine	1 kHz	4 div	9R45	CH3 LEVEL ADJ
2	B triggering			B DC	B CH4					9R46	CH4 LEVEL ADJ

Check and adjustment	1. Check that the triggering level is the middle of the input signal amplitude when A SOURCE switch is set to CH3 and A LEVEL control is set to the midrange. If not the middle, adjust with 9R45 CH3 LEVEL ADJ. 2. Turn B SOURCE switch to CH4 and perform the same check as above. If not the middle, adjust with 9R46 CH4 LEVEL ADJ *Precaution* *As the CH3 POSITION (previously described) is altered when 9R45 is used for adjustment and the CH4 POSITION altered when 9R46 is used for adjustment, the "CH3・CH4 Center position" item should be checked again.*
Related Items	6-9-8

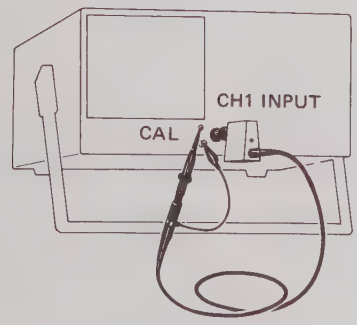
Figure 6-10-3. Adjustment locations (CH3・CH4 TRIGGERING LEVEL)

6-11 HORIZONTAL DEFLECTION SYSTEM

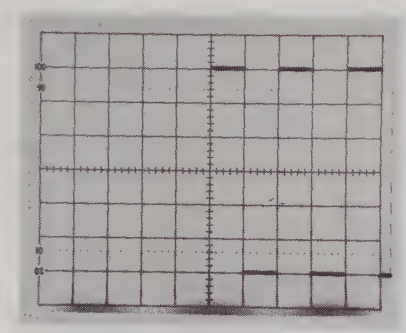
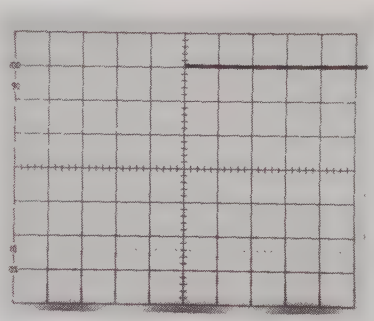
6-11-1 Average Voltage Horizontal Amplifier

Item	Description
Rating	+65 V ±5V
Setting	Set HORIZ DISPLAY switch to X-Y and move the bright spot to the center of the screen.
Check and adjustment	Use a digital multimeter to measure the voltage between the collector of 18Q32 and GND. If this voltage is not within 65 V±5V, adjust with the 18R59 LEVEL ADJ (see Figure. 6-11-1).

6-11-2 Magnification Center

Item	Description
Connection	SS-5711 
Setting	Swing CRT amplitude by 6 div.
Check and adjustment	With the horizontal POSITION, set the sweep start point (rise of CAL waveform) to the vertical center line of scale, pull FINE (PULL X 10 MAG), and check the motion of the sweep start point. If the motion width is great, adjust with 18 R56 MAG CENT (see figure 6-11-1).
Related Item	6-12-2

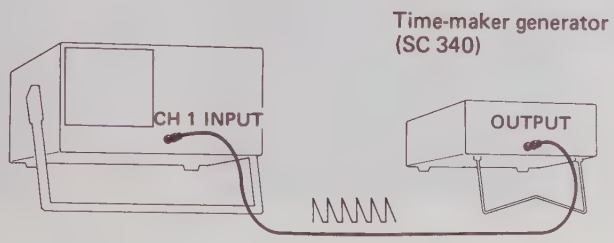
6-11-2 Magnification (Cont)

Item	Description
CRT waveform	X 1  X 10 MAG 

6-11-3 A · B Sweep Start

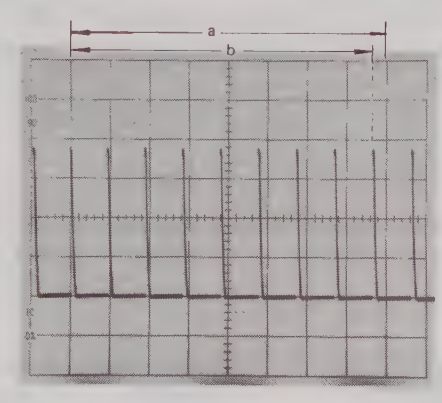
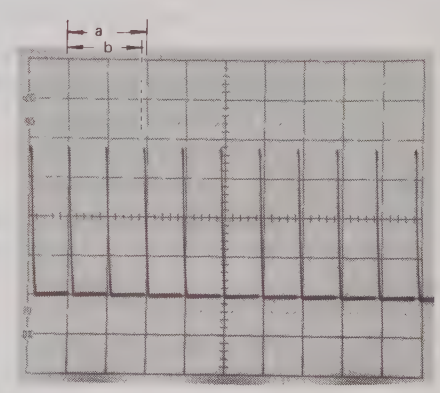
Item	Description	
Setting	HORIZ DISPLAY	ALT
	B TIME/DIV	1mS
	B sweep source	RUNS AFTER DELAY
Check and adjustment	Turn TRACE SEPARATION and move B sweep trace to a little above A INTEN sweep trace. Check at this time both start points of A INTEN sweep trace and B sweep trace are at the same position on the vertical line of the scale. If the check result shows a separation, adjust it with 17R11 A • B START ADJ (see figure 6-11-1).	

6-11-4 Sweep Rate

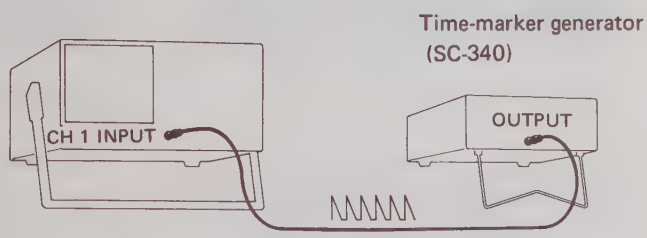
Item	Description
Rating	I. ± 2% at 8 div at center of screen. II. ± 5% within any 8 div on screen.
Connection	SS-5711 
Setting	See table below
Check and adjustment	1. Adjust the start pulse to 1 div to the right of the left edge of the scale and check errors I and II. If out of the rating, adjust with 18R36 A SWP CAL (see Fig. 6-11-1). 2. Adjust input signal repetition to A TIME/DIV and check errors I and II for 0.5 S to 0.1 mS. 3. Adjust input signal repetition to A TIME/DIV switch and check errors I and II for 50 μS to 20 nS. If out of the rating, adjust with 13C43 (see Figure. 6-11-1). 4. Select B sweep and perform the same check as in 1 step. If out of the rating, adjust with 15R73 B SWP CAL (see Figure. 6-11-1). 5. Adjust input signal repetition to B TIME/DIV switch and check errors I and II for 50 mS to 0.1 mS. 6. Adjust input signal repetition to B TIME/DIV switch and check errors I and II for 50 μS to 20 nS. If out of the rating, adjust with 14C43 (see Figure. 6-11-1).

Sequence	Item	SS-5711 TIME/DIV	Input signal REPETITION	Calibrator Circuit No.	Calibrator Name
1	A sweep	1 mS	1 mS	18R36	A SWP CAL
2		0.5 S to 0.1 mS	Adjust to required TIME/DIV value		
3		50 μS to 20 nS		13C43	–
4	B sweep	1 mS	1 mS	15R73	B SWP CAL
5		50 mS to 0.1 mS	Adjust to required TIME/DIV value		
6		50 μS to 20nS		14C43	–

6-11-4 Sweep Rate (Cont.)

Item	Description
CRT waveform	Sweep time error I  Sweep time error ratio = $\frac{a - b}{a} \times 100$ Sweep time error ratio = where a: effective horizontal surface total scale length (8 div) b: marker corresponding to "a"
	Sweep time error II  Sweep time error ratio = $\frac{a - b}{a} \times 100$ Sweep time error ratio = where a: any 2 div in effective horizontal surface b: measured value of time marker corresponding to "a"

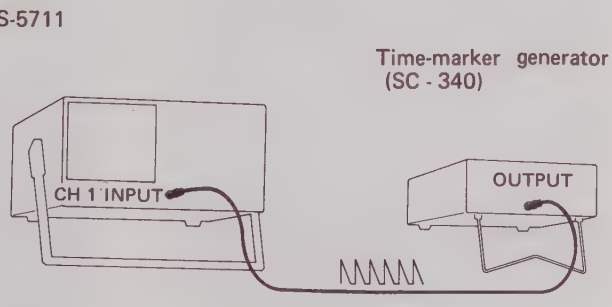
6-11-5 Magnified Sweep Rate

Item	Description
Rating	I. At 8 div at center of screen. 20 nS/div, 50 nS/div ± 5% 0.1 μS/div to 0.5S/div ± 3% II. Within any 8 div. on screen 20 nS/div,50 nS/div ± 10% 0.1μ S/div to 0.5 μS/div ± 6% 1μ S/div to 0.5 S/div ± 5% Except for 30 nS from the sweep start point and 40 nS from the end point with items 1 and 2.
Connection	SS-5711 
Setting	<table><tr><th rowspan="2">Sequence</th><th rowspan="2">Item</th><th colspan="2">SS-5711</th><th>Input signal</th><th colspan="2">Calibrator</th></tr><tr><th>FINE (PULL X 10)</th><th>TIME/DIV</th><th>REPETITION</th><th>Circuit No.</th><th>Name</th></tr><tr><td>1</td><td rowspan="3">A sweep</td><td rowspan="4">(PULL X 10) MAG) pulled out</td><td>1 mS</td><td>0.1 mS</td><td rowspan="2">18R31</td><td rowspan="2">MAG GAIN</td></tr><tr><td>2</td><td>0.5 S to 1 μS</td><td rowspan="3">Adjust to required TIME/DIV value</td></tr><tr><td>3</td><td>0.5 μS to 20 nS</td><td>18C75, 18C94</td><td rowspan="2">–</td></tr><tr><td>4</td><td>B sweep</td><td>50 mS to 20 nS</td><td>–</td></tr></table>
Check and adjustment	1. Adjust the start pulse to 1 div to the right of the left edge of the scale and check errors I and II. If out of the rating, adjust with 18R31 MAG GAIN (see Figure. 6-11-1). 2. Adjust input signal repetition to A TIME/DIV switch and check errors I and II for 0.5 S to 0.1 μ S.

6-11-5 Magnified Sweep Rate (Cont)

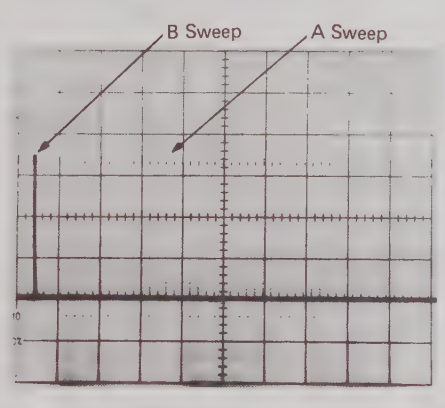
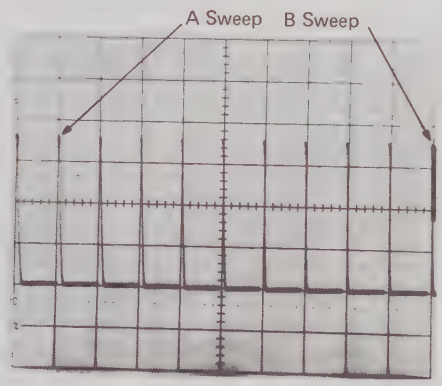
Item	Description
	3. Adjust input signal repetition to a TIME/DIV switch and check errors I and II for 0.5μ S to 20 nS. If out of the rating, adjust with 18C75 and 18C94 (see Figure. 6-11-1). 4. Select B sweep and perform the same check as in 1 step.
CRT waveform	See Figure. 6-11-5.

6-11-6 Start and Stop of Delay

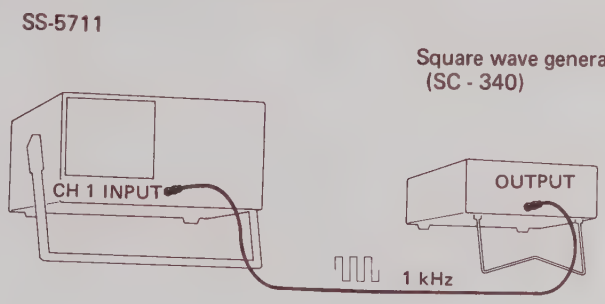
Item	Description
Rating	± 1% of reading ±0.01 scale (DELAY TIME MULT dial minimum scale)
Connection	
Setting	

Sequence	SS-5711				Input Signal	Calibrator	
1	B HORIZ DISPLAY	B TIME/ DIV	B SOURCE	DELAY TIME MULT dial	REPETITION	Circuit No.	Name
2	A INTEN	5 μS	RUNS AFTER DELAY	0.40	0.2 mS	14R92	DLY START
				10.00	1 mS	14R96	DLY STOP

6-11-6 Start and Stop of Delay (Cont)

Item	Description
Check and adjustment	1. Set the DELAY TIME MULT dial to 0.40 and check that the B sweep is at the 3rd, pulse from sweep start (as shown in CRT waveform). If out of the rating, adjust with 14R92 DLY START (see Figure 6-11-1). 2. Turn the DELAY TIME MULT dial to the right and set it to 10.000 and check that the B sweep is at the 11th pulse (as shown in CRT waveform). If out of the rating, adjust with 14R96 DLY STOP (see Figure. 6-11-1). *Precaution* *As items 1 and 2 effect each other, the adjustments should be repeated a number of times.*
CRT waveform	DELAY TIME MULT start location  A TIME/DIV 1 mSEC, B TIME/DIV 5 μS Input signal: 0.2 mS pulse wave DELAY TIME MULT dial: scale 0.40 DELAY TIME MULT stop location  A TIME/DIV 1 mSEC, B TIME/DIV 5 μS Input signal: 1 mS pulse wave DELAY TIME MULT dial: scale 10.00

6-11-7 Jitter

Item	Description
Rating	1/20,000 or less
Connection	
Setting	

SS-5711				Input signal		Screen amplitude
HORIZ DISPLAY	B TIME/DIV	B SOURCE	DELAY TIME MULT dial	Wave-form	Repeti-tion	
B (DLY'D)	0.5 μS	RUNS AFTER DELAY	10.00	Square wave	1 mS	approx 2 div

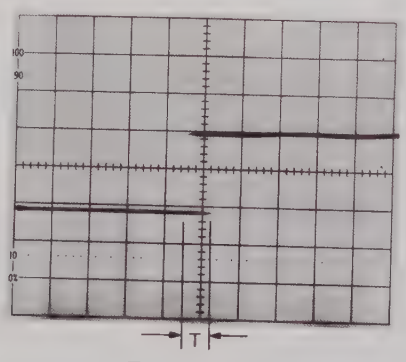
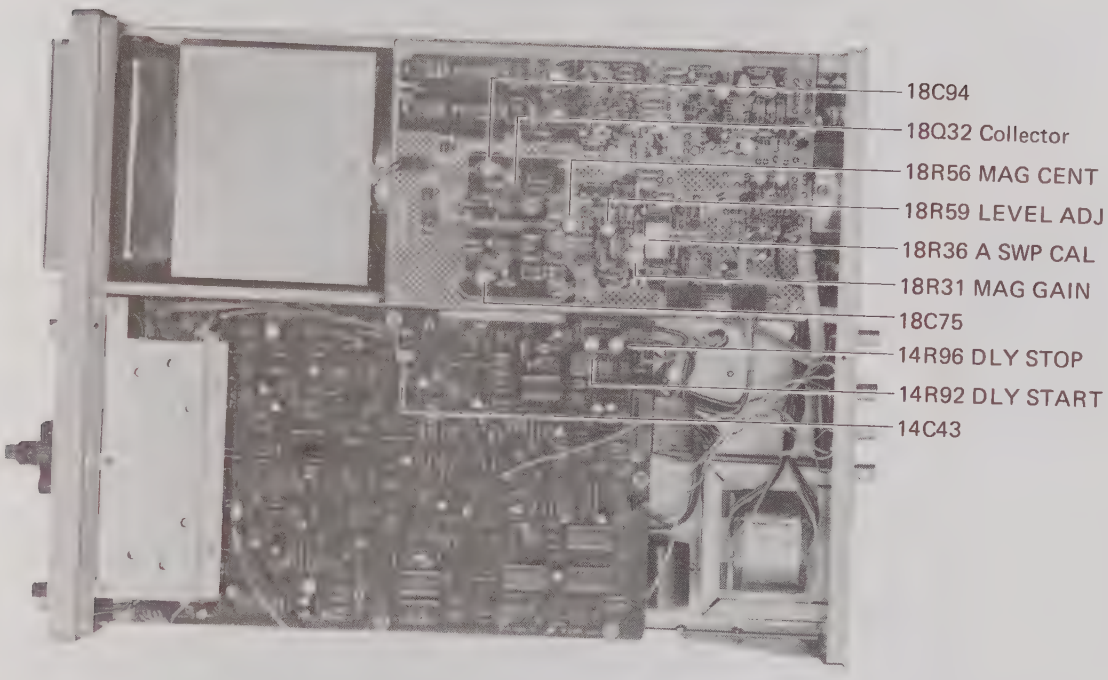
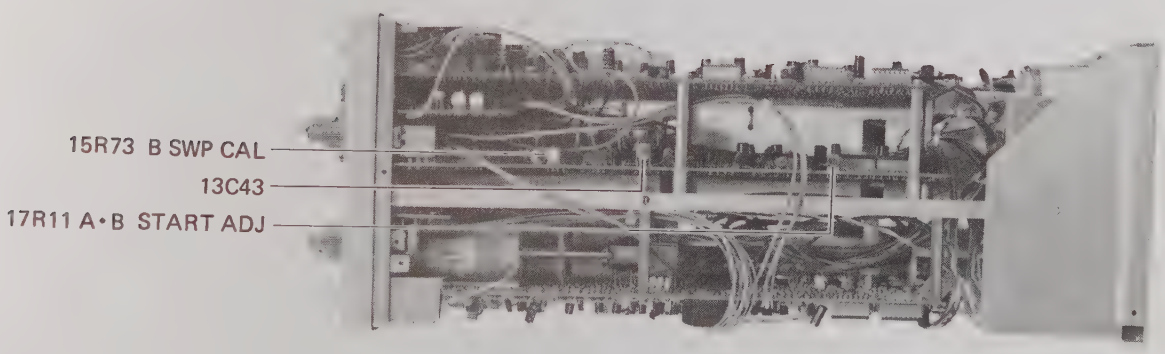
Check	Gradually turn the DELAY TIME MULT dial towards 10.00 so that the rising edge of the pulse is displayed on the screen. Check that jitter in this case is less than 1 div.
CRT waveform	 T = 1 div or less A TIME/DIV 1mS B TIME/DIV 0.5 μS DELAY TIME MULT dial scale near 10.00

Figure 6-11-1. Adjustment locations (HORIZONTAL DEFLECTION SYSTEM)

Top

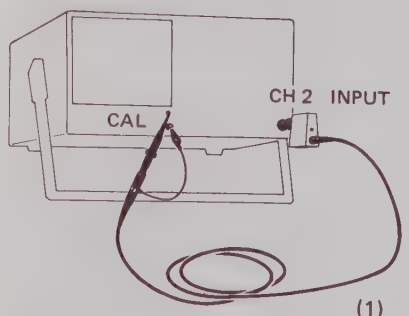


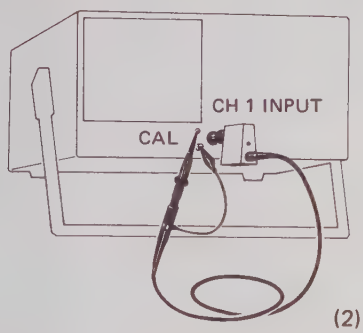
Right



6-12 X-Y OPERATION

6-12-1 Deflection Factor

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Connections</td><td>Figure 1 SS-5711
 

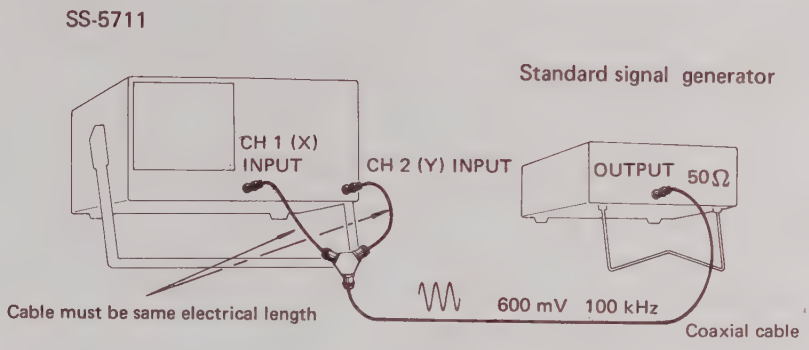
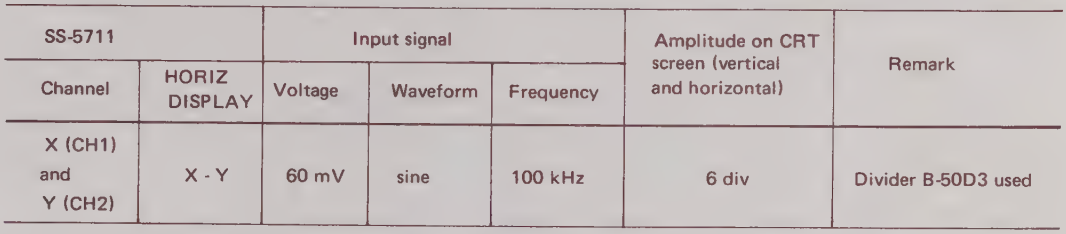
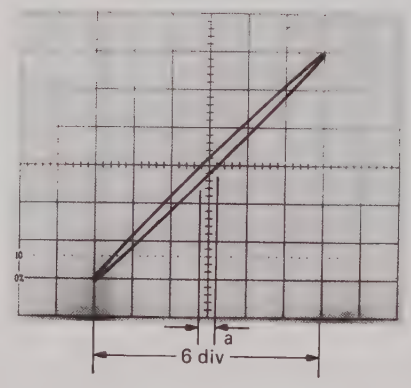
(1)
Figure 2 SS-5711
 

(2)</td></tr>
<tr><td>Setting</td><td><table>
<tr><th>Sequence</th><th>Connection</th><th>HORIZ DISPLAY</th></tr>
<tr><td>1</td><td>1</td><td rowspan="2">X – Y</td></tr>
<tr><td>2</td><td>2</td></tr>
</table></td></tr>
<tr><td>Check and adjustment</td><td>1. Using the supplied probe, apply CAL 0.6 V to the CH2 INPUT and check that the vertical amplitude is within 6 div ±2%.
2. Using the supplied probe, apply CAL 0.6V to the CH1 INPUT and check that the vertical amplitude is within 6 div. ±3%. If out of the rating, adjust with 3R113 X-Y GAIN (see Figure. 6-12-1).</td></tr>
</table>

6-12-2 Spot Location

Item	Description
Setting	Vert MODE CH 2
Check and adjustment	Set ⟷ POSITION control and FINE control to the center, and check that the spot is on the vertical center-line when HORIZ DISPLAY is turned to X-Y .If the bright spot is noticeably distant from the vertical center line, adjust with 3R117 X-Y POS (see Figure. 6-12-1).

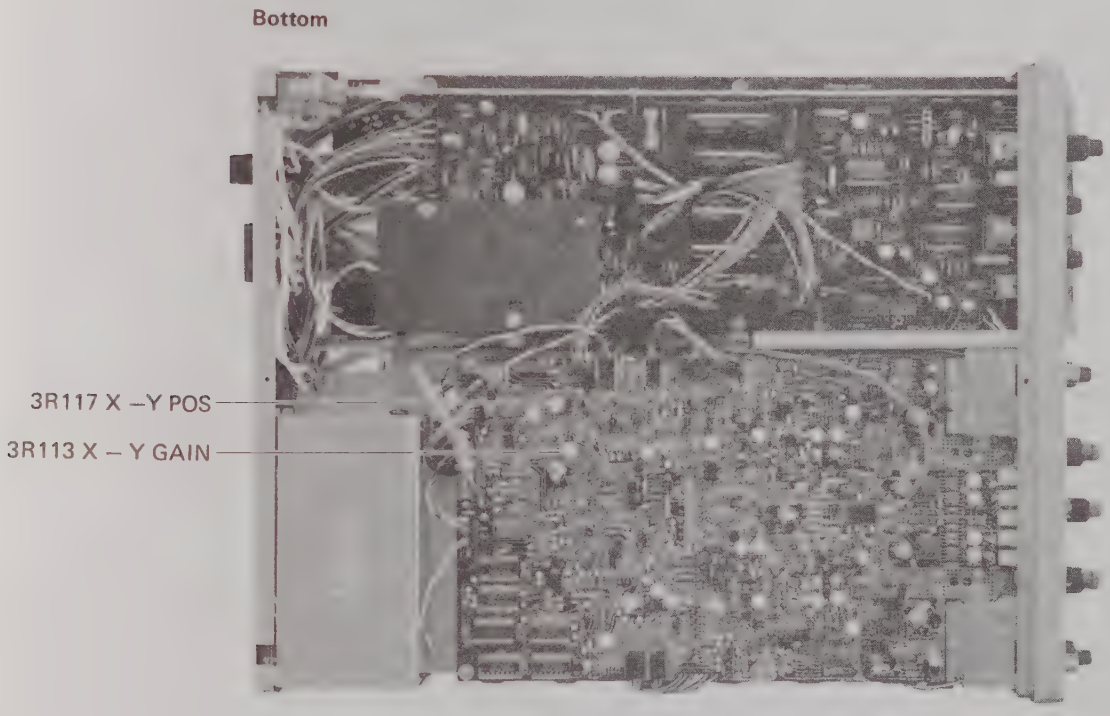
6-12-3 Phase Difference

Item	Description
Rating	Within 3°(DC to 100 kHz sine wave)
Connection	
Setting	
Check	Read "a" on the screen and check the reading is less than 0.3 div.
CRT waveform	

SS-5711		Input signal			Amplitude on CRT screen (vertical and horizontal)	Remark
Channel	HORIZ DISPLAY	Voltage	Waveform	Frequency		
X (CH1) and Y (CH2)	X - Y	60 mV	sine	100 kHz	6 div	Divider B-50D3 used

a : Opening at horizontal center line

Figure 6-12-1. Adjustment locations (X – Y operation)



6-13 COUNTER

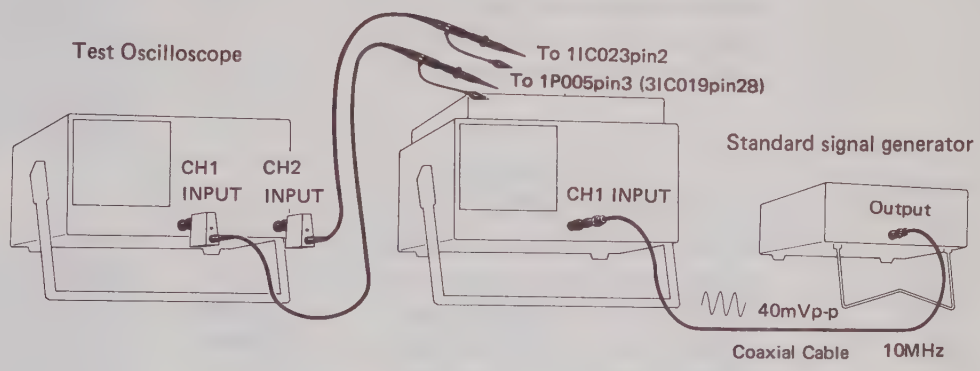
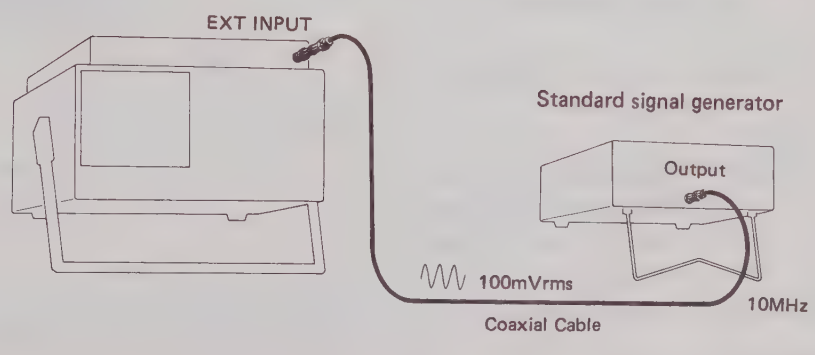
6-13-1 Power Supply DC Level

Item	Description
Rating	DC power voltage: +12 V, +5 V, −5 V — Output voltage range: Within ± 5%
Check and adjustment	Measure the voltage between the test points (see Fig. 6-13-1) and GND with a digital multimeter and check that the voltage is within ±5% of the rating.

6-13-2 Self CHECK

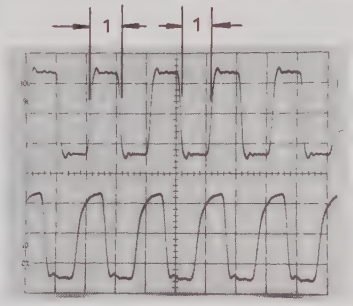
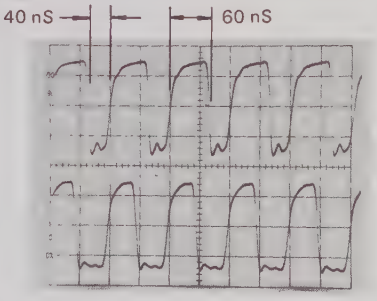
Item	Description
Rating	Range: 0.01 — Computed values: 10000.0 ± 1 count — Units: kHz Range: 0.1 — Computed values: 10000.00 ± 1 count — Units: kHz Range: 1 — Computed values: 10000.000 ± 1 count — Units: kHz Range: 10 — Computed values: Δ0.000.000 or 9999.9999 — Units: kHz <Reference> At Δ0.000.0000 scale exceeded.
Setting	Set the function switch to CHECK.
Check and adjustment	Check that the selected range values are with the respective ratings.

6-13-3 FREQ Measurement Mode

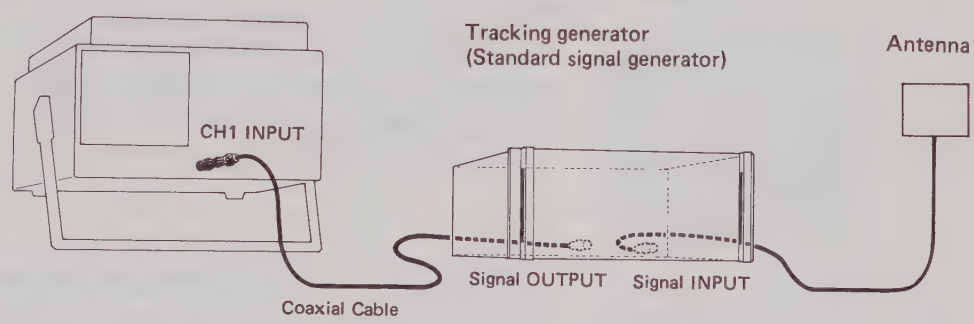
Item	Description
Connection	(1) SS-5711D  (2) SS-5711D 

Setting

Sequence	Connection	Test socilloscope		SS-5711D				Input signal			Displayed value	Calibrator
				Counter								
		CH1 connected to:	CH2 connected to:	FREQ	INT -EXT	LF -HF	Measurement range	Voltage	Waveform	Frequency		Circuit No.
1	(1)	1P005 pin 1	1IC023 pin 2	IN (push)	INT	LF	0.1S	40 mV p-p	sine	10 MHz	—	1R020
2		3IC019 pin 28									10,000 kHz	1C056
3		—	—			HF					10 MHz	—
4	(2)				EXT			100 mV rms				

Item	Description
Check and adjustment	1. Adjust the A sweep level and set as in the diagram at right so that the waveform at 1P005 Pin 1 has a 1 : 1 duty ratio. Check that the waveform at 1IC023 pin 2 is as shown in the diagram at right. If it is not, adjust with 1R020 (see Fig. 6-13-1). 1P005 pin 1 waveform 1IC023 pin 2 waveform 
	2. Connect the CH1 probe to 3IC019 pin 28 (see Fig. 6-13-1) and check that the waveform is in the diagram at right. If it is not, adjust with 1C056 (see Fig. 6-13-1). After the two adjustments described above are completed, check that the display indicates 10,000 kHz. 3. Set LF-HF to HF and check that the display indicates 10 MHz. 4. Set INT-EXT to EXT, apply the output of the standard signal generator to EXT INPUT [see Connection (2)], and check that the display indicates 10 MHz. 3IC019 pin 28 waveform 

6-13-4 Standard Oscillator

Item	Description
Rating	10 MHz $\pm 5 \times 10^{-7}$/week
Connection	SS-5711D 
Setting	See table below
Check and adjustment	Synchronized at the A sweep level and check that the displayed frequency is 10000.000 kHz or 9999.999 kHz. If it is neither, adjust with 5C308 (see Fig. 6-13-1).

SS-5711D				Input signal	Displayed valve	Calibrator
FREQ	INT-EXT	LF-HF	Measurement range	Frequency		Circuit No.
IN (push)	INT	LF	IS	10 MHz	10000.000 kHz or 9999.999	5C308

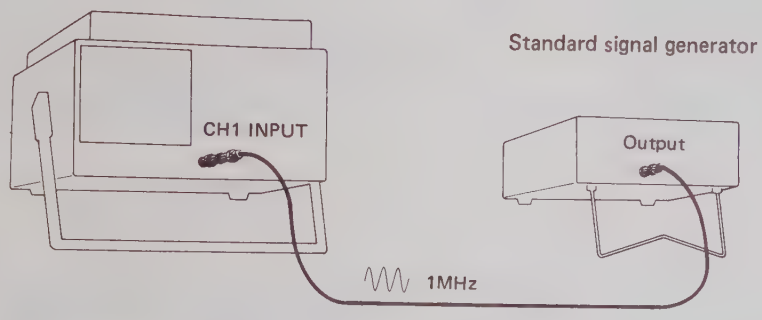
6-13-5 PERIOD Measurement Mode

Item

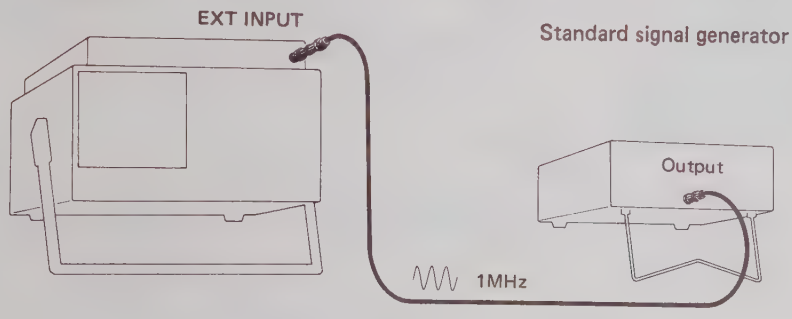
Description

Connection

(1) SS-5711D



(2) SS-5711D



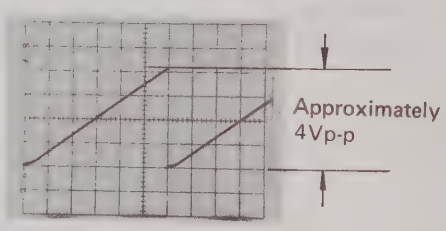
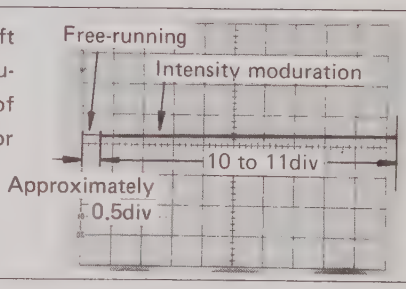
Setting

Sequence	Connection	SS-5711D				Input signal		Displayed value
		PERIOD	IN-EXT	LF-HF	Measurement range	Waveform	Frequency	
1	(1)	IN (push)	INT	LF	1 period	sine	1 MHz	1.0μS
2							Frequency increased	Indicator blinks at 0.4μS to 0.2μS
3	(2)		EXT	HF			1 MHz	1000.0nS

Check

1. Synchronize at the A sweep level and check that the displayed time is 1.0 μsec.
2. Increase the input repeat frequency and check that the unit display indicator blinks at a displayed value of between 0.4 μsec and 0.2 μsec.
3. Apply the standard signal generator output to EXT INPUT and check that the displayed value is 1000.0 nsec.

6-13-6 TIME INTERVAL Measurement Mode

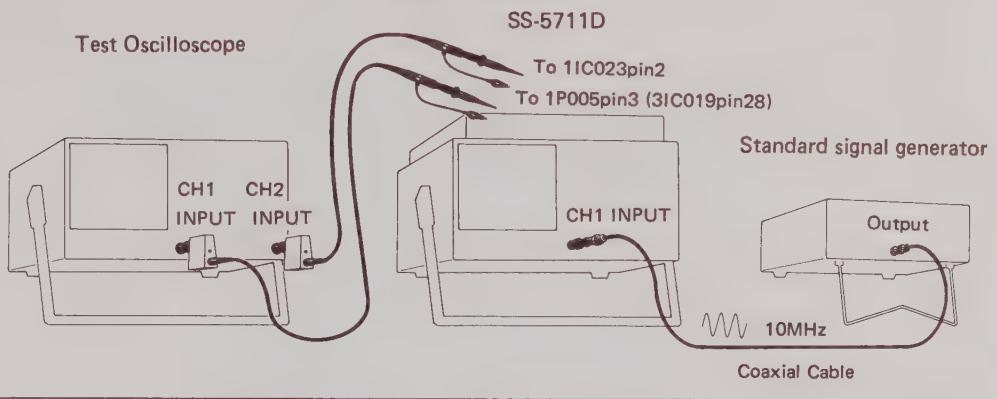
Item	Description	
Setting	TIME INT	IN (push)
	A TIME/DIV	1 mSEC
	A sweep	Free run sweep
Check and adjustment	1. Use an oscilloscope to measure the 2Q004 emitter waveform. Check that the amplitude of the sawtooth waveform is approximately 4 Vp-p (see diagram at right). If the error is too great, adjust with 2R033 (see Fig. 6-13-1).	2Q004 emitter waveform 
	2. Turn the START cursor as far as possible to the left and check that the start point of the brightness modulated portion is approximately 0.5 div. to the right of the sweep start point (see diagram at right). If the error is too great, adjust with 2R044 (see Fig. 6-13-1).	
	3. Turn the START cursor as far as possible to the right and check that the brightness modulated portion is approximately 10.5div. in length. If the error is too great, adjust with 2R046 (see Fig. 6-13-1).	
	4. Move the START and STOP cursors to set the length of the brightness modulated portion to 10 div. and check that the value on the display is approximately 10000.0 μsec.	
	5. Move the START and STOP cursors to set the displayed value and check that the unit display indicator blinks when the displayed value is between 0.4 μsec and 0.2 μsec. If the indicator blinks at a value outside this range, adjust with 5R303 (see Figure 0-13-1).	

6-13-7 DELAY TIME Measurement Mode

Item	Description
Setting	DELAY TIME IN (push) HORIZ DISPLAY A INTEN B sweep SOURCE RUNS AFTER DELAY
Check and adjustment	Turn DELAY TIME MULT and check that the delay time and displayed value are equal. Check that the unit display indicator blinks when the displayed value is between 0.4 μsec and 0.2 μsec.

6-13-8 A EVENT IN DELAY TIME Measurement Mode

Item: Connection



Setting

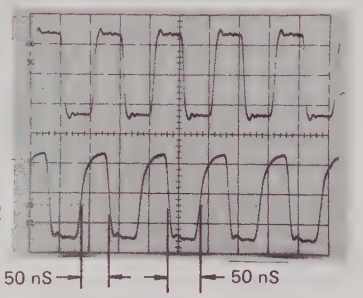
Sequence	SS-5711D						Input signal		Calibrator
	Oscilloscope					Counter			
	HORIZ DISPLAY	A TIME/ DIV	B sweep source	B TIME/ DIV	A LEVEL	A EVENT IN D TIME	Waveform	Frequency	Circuit No.
1	A INTEN	1 ms	RUNS AFTER DELAY	10 μS	Synchro-nized	IN (push)	sine	10 MHz	1R071
2		0.1 μS		50 ns					–

Check and adjustment

1. Connect CH1 of a measurement oscilloscope to 1P005 Pin 1 , and CH2 to 1IC023 pin 2 and check that the waveform is as shown at right. If it is not, adjust with 1R071 (see Fig. 6-13-1).

Waveform of 1P005 Pin1

Waveform of 1IC023 Pin 2



2. Set A TIME DIV to 0.1 μsec and B TIME/DIV to 50 nsec., turn DELAY TIME MULT, and check that 5 appears on the display when the waveform at right is on the screen.

Waveform on screen.

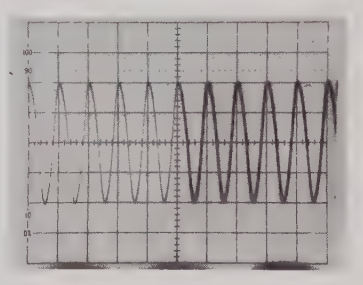
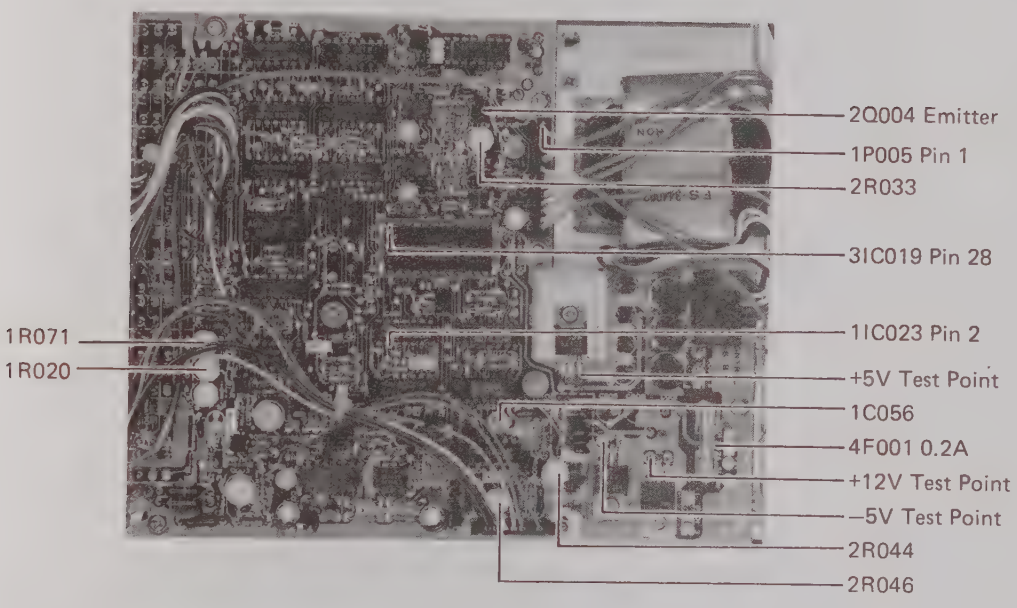
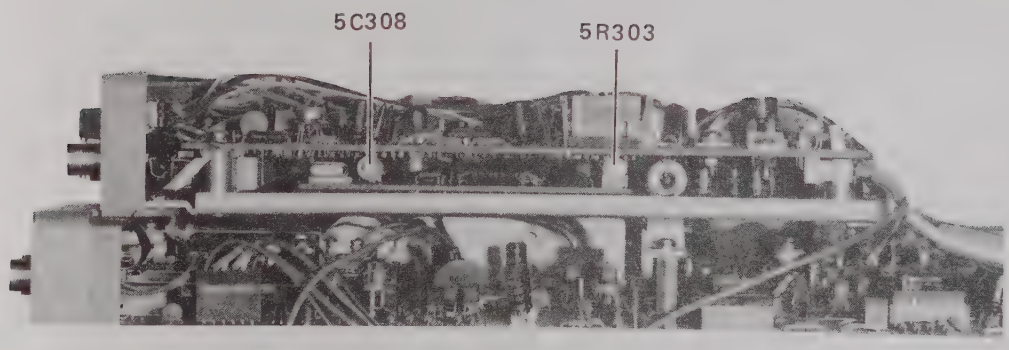


Figure 6-13-1 Adjustment and testpoint locations (COUNTER)

Top



Right



6-14 DIGITAL MULTIMETER

Caution

The digital multimeter circuit contains the following three types of GND. This point should be noted during checks and adjustment.

GND type	Circuit symbol
General GND (chassis)	⏚
Analog GND	▽
Digital GND	▼

6-14-1 Power Supply DC Level

Item	Description
Rating	DC power voltage: +5 V — Output voltage range: Within ± 4% DC power voltage: −5 V — Output voltage range: Within ± 10%
Check	Measure the voltage between the test points (see Fig. 6-14-1) and check that they are within the ratings.
Check	*Caution* *Confirm that the voltage between 1F101 (see Figure. 6-14-1) and general GND (chassis) is within +5V ±10% before check.* 1. Measure the voltage bettween + side of 1C101 (see Figure 6-14-1) and digital GND (−side of 1C101) with a digital multi-meter and check that the voltage is within +5V ± 4%. 2. Measure the voltage between −side of 1C105 (see Figure. 6-14-1) and digital GND (+side of 1C105) with a digital multimeter and check that the voltage is within −5V ± 10%.

6-14-2 DC Voltage Measurement

Item	Description
Rating	200 mV to 200 V ±0.25% of rdg ±0.05% of range 1000 V ±0.25% of rdg ±0.1% of range

Setting

Sequence	SS-5711D			Input voltage	Display range	Calibrator	
	Function	AC-DC	Range			Ciruict No.	Name
1	V	DC	200 mV	+190.0 mV	189.4 to 190.6	1R121	DC 200 mV ADJ
				−190.0 mV	−189.4 to −190.6		
				Signal input terminal shorted	−00.1 to +00.1	−	−
2			2 V	+1.900 V	1.894 to 1.906	1R102	DC 2 V ADJ
				−1.900 V	−1.894 to −1.906		
				Signal input terminal shorted	−00.1 to +00.1		
3			20 V	+19.00 V	18.94 to 19.06	−	−
				−19.00 V	−18.94 to −19.06		
4			200 V	+190.0 V	189.4 to 190.6		
				−190.0 V	−189.4 to −190.6		
5			2000 V	+1000 V	997 to 1003		
				−1000 V	−997 to −1003		

Check and adjustment

Select the range in accordance with the input voltage and check that the individual display values are within the display range. If the error is too great, adjust with 1R121 DC 200 mV ADJ for the 200 mV range (see Fig. 6-14-1) and with 1R 102 DC 2V ADJ for the 2 V range (see Fig. 6-14-1). Other ranges are checked only, no adjustments are required.

6-14-3 AC Voltage Measurement

Item	Description
Rating	200 mV to 200 V ±0.75% of rdg ±0.25% of range 750 V ±10% of rdg ±0.4% of range

Setting

Adjustment sequence	SS-5711D			Input signal		Display range	Calibrator	
	Function	AC-DC	Range	Voltage	Frequency		Circuit No.	Name
1	V	AC	200 mV	190.0 mV	100 Hz	188.1 to 191.9	1R137	AC V ADJ
				Signal input terminal shorted	–	0.00 to 00.5	–	–
2			2 V	1.900 V	100 Hz	1.881 to 1.919		
3			20 V	19.00 V	500 Hz	18.18 to 19.19		
4			200 V	190.0 V		188.1 to 191.9		
5			2000 V	750 V		740 to 760		

Check and adjustment

Select the range in accordance with the input voltage and check that the individual display values are within the display range. If the error is too great, adjust with 1R137 AC V ADJ for the 200 mV range (see Fig. 6-14-1).
Other ranges are checked only, no adjustments are required.

6-14-4 Resistance Measurement

Item	Description
Rating	200 Ω to 200 kΩ ±0.25% of rdg ±0.05% of range 20000 kΩ ±0.5% of rdg ±0.1% of range 20 MΩ ±2% of rdg ±0.1% of range
Setting	

Sequence	SS-5711D		Measure Resistor	Display Range	Calibrator	
	Function	Range			Circuit No.	Name
1	Ω	200 Ω	0 (Shorted)	00.00 to 00.1	1R129	200Ω 0 ADJ
2			190.0 Ω	189.4 to 190.6	1R147	200 Ω ADJ
3		2 kΩ	1.900 kΩ	1.894 to 1.906	–	–
4		20 kΩ	19.00 kΩ	18.94 to 19.06		
5		200 kΩ	190.0 kΩ	189.4 to 190.6		
6		2000 kΩ	1900 kΩ	1889 to 1911		
7		20 MΩ	19.00 MΩ	18.60 to 19.40		

Check and adjustment

Caution

Use measuring leads and high resistance cables (optional) when checking performance and adjusting.
When using input cables, the resistance of the cables must be considered.
Use shielded wire for input cables. Ensure that these cables and the resistor being measured is not touched during testing.

Select the range in accordance with the resistor being measured and check that the individual display values are within the display range. If the error is too great, adjust with 1R129 200 Ω 0 ADJ and 1R147 200 Ω ADJ (see Fig. 6-14-1). Other ranges are checked only, no adjustments are required.

6-14-5 DC Current Measurement

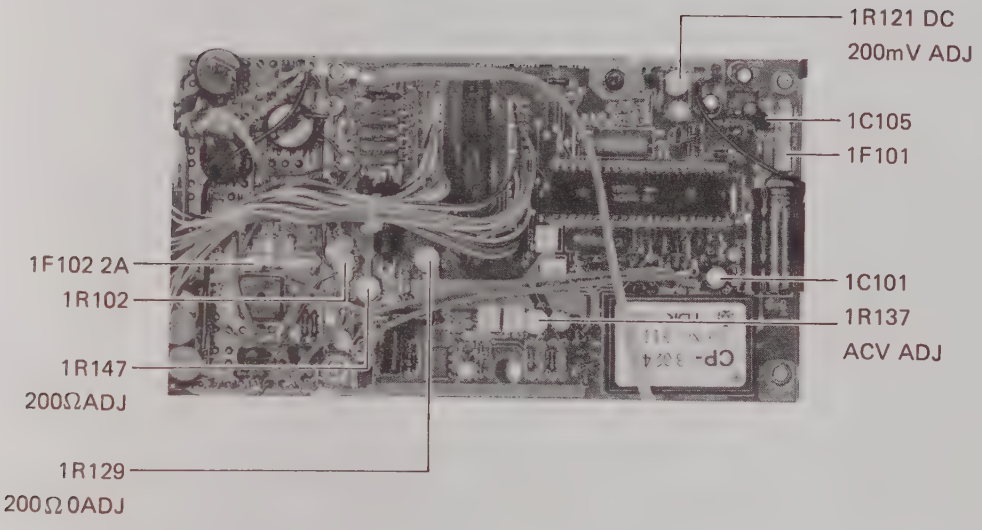
<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Rating</td><td>2 mA to 200 mA ±0.8% of rdg ±0.05% of range
2000 mA ±2% of rdg ±0.05% of range</td></tr>
<tr><td>Setting</td><td>
<table>
<tr><th colspan="3">SS-5711D</th><th rowspan="2">Input current</th><th rowspan="2">Display range</th></tr>
<tr><th>Function</th><th>AC-DC</th><th>Range</th></tr>
<tr><td rowspan="6">A</td><td rowspan="6">DC</td><td rowspan="2">2 mA</td><td>0</td><td>.000 to .001</td></tr>
<tr><td>1.900 mA</td><td>1.884 to 1.916</td></tr>
<tr><td>20 mA</td><td>19.00 mA</td><td>18.84 to 19.16</td></tr>
<tr><td>200 mA</td><td>190.0 mA</td><td>188.4 to 191.6</td></tr>
<tr><td>2000 mA</td><td>1900 mA</td><td>1861 to 1939</td></tr>
</table>
</td></tr>
<tr><td>Check</td><td>Select the range in accordance with the resistor being measured and check that the individual display values are within the display range.</td></tr>
</table>

6-14-6 AC Current Measurement

Item	Description
Rating	±2% of rdg ±0.25% of range
Setting	See table below
Check	Select the range in accordance with the resistor being measured and check that the individual display values are within the display range.

SS-5711D			Input current		Display range
Function	AC-DC	Range	Current	Frequency	
A	AC	2 mA	0 mA	—	.000 to .005
			1.900 mA	500 Hz	1.857 to 1.943
		20 mA	19.00 mA		18.57 to 19.43
		200 mA	190.0 mA		185.7 to 194.3
		2000 mA	1900 mA		1857 to 1943

Figure 6-14-1 Adjustment locations (DIGITAL MULTIMETER)



NOTES

Schematic Diagrams

Voltages and Waveforms

In the schematic diagrams, the voltages and waveforms in the normal operation of the instrument are as shown.

They are useful for troubleshooting.

These voltages and waveforms are measured according to the following conditions:

1. The CAL 1kHz 0.6V connector is connected to the INPUT connector by 10 : 1 passive prove as the test signal.

2. Exceptions in the controls setting are shown by "VOLTAGE & WAVEFORM READING CONDITIONS" noted on the schematic diagram. Beside, the asterisks maked on the diagram show the point measured by the excepitional settings.

3. The waveforms starting from the negative slope are measured by setting the SLOPE switch of a test oscilloscope to (–).

4. The switches and controls of this instrument is set as follows:

–Power supply & CRT circuit–

POWER	ON
SCALE	Arbitrary position
INTEN	Best desired
FOCUS	Best focused display

–Vertical deflection system–

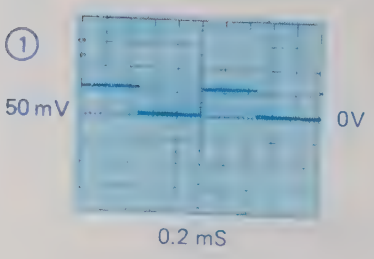
AC-GND-DC (CH1-2)	DC
VOLTS/DIV	10mV/div
VARIABLE (CH1-2)	CAL
AC-DC (CH3)	DC
0.1V-1V	0.1V
POSITION (CH1,2,3,4)	Mid position
MODE	CH1
CH2 POLAR	NORM (▲)
BANDWIDTH	FULL (▲)

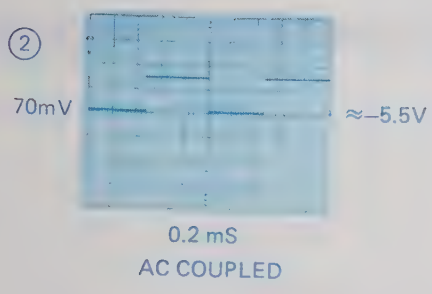
–Horizontal deflection system–

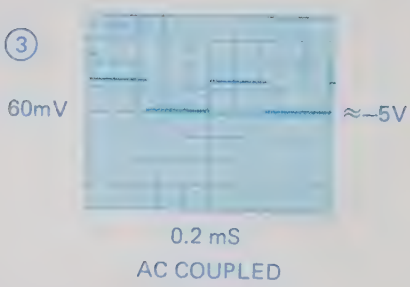
HORIZONTAL	A
MODE	AUTO
A TIME/DIV	1mS/div
A VARIABLE	CAL
B TIME/DIV	1mS/div
DELAY TIME MULT	Counter-clockwise Set the start portion of the trace to the left-end of vertical graticule.
FINE (Pull x 10 MAG)	Push Mid position
HOLD OFF	NORM (Counter-clockwise)

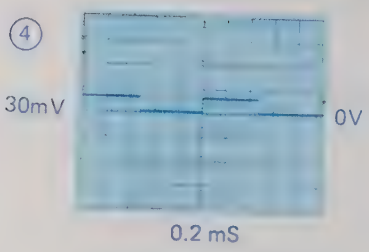
–Trigger system–

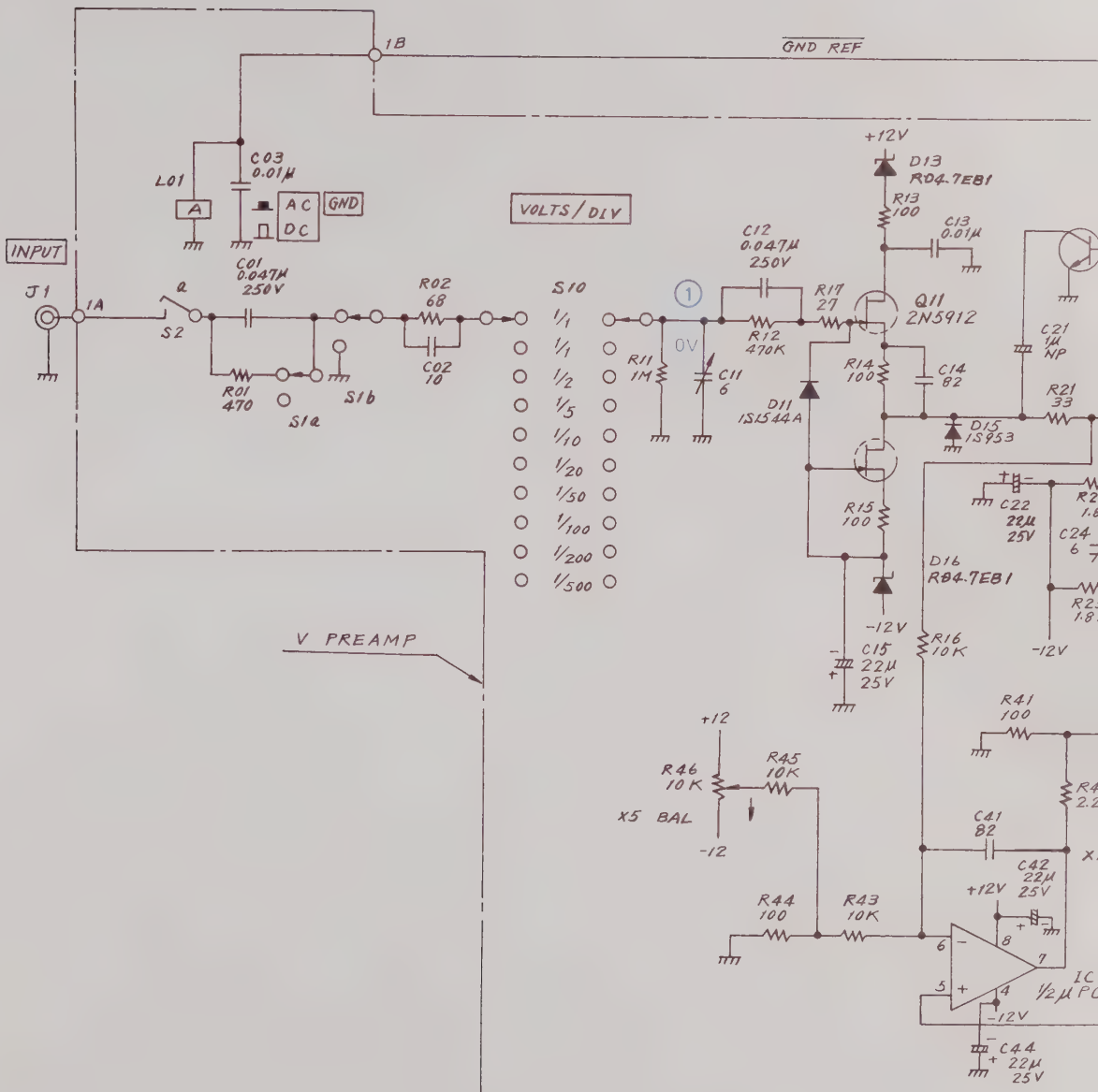
SOURCE	CH1
COUPLING	AC
LEVEL-SLOPE (pull–)	Push, Trigger

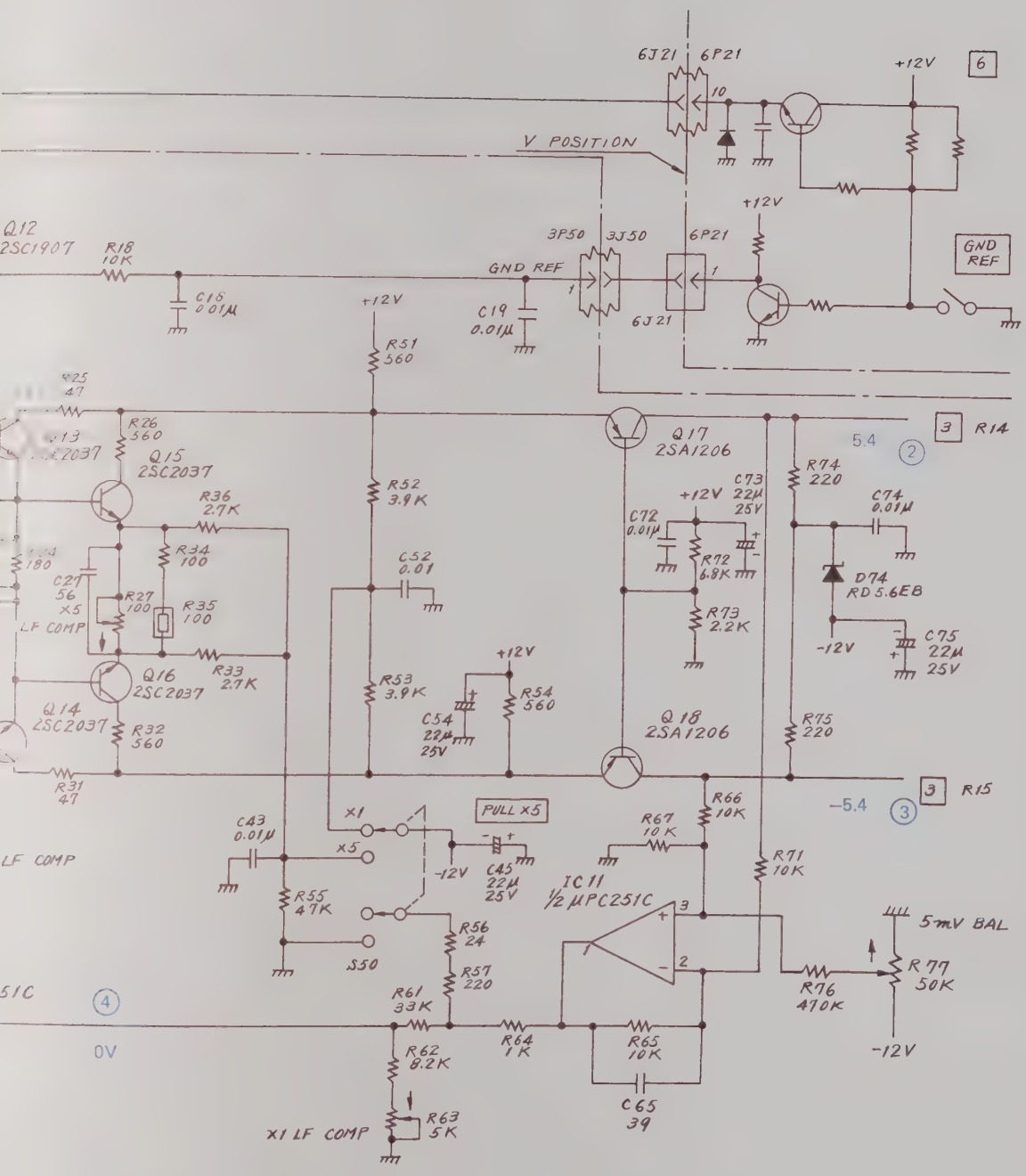

①
50 mV
0V
0.2 mS


②
70mV
≈–5.5V
0.2 mS
AC COUPLED


③
60mV
≈–5V
0.2 mS
AC COUPLED

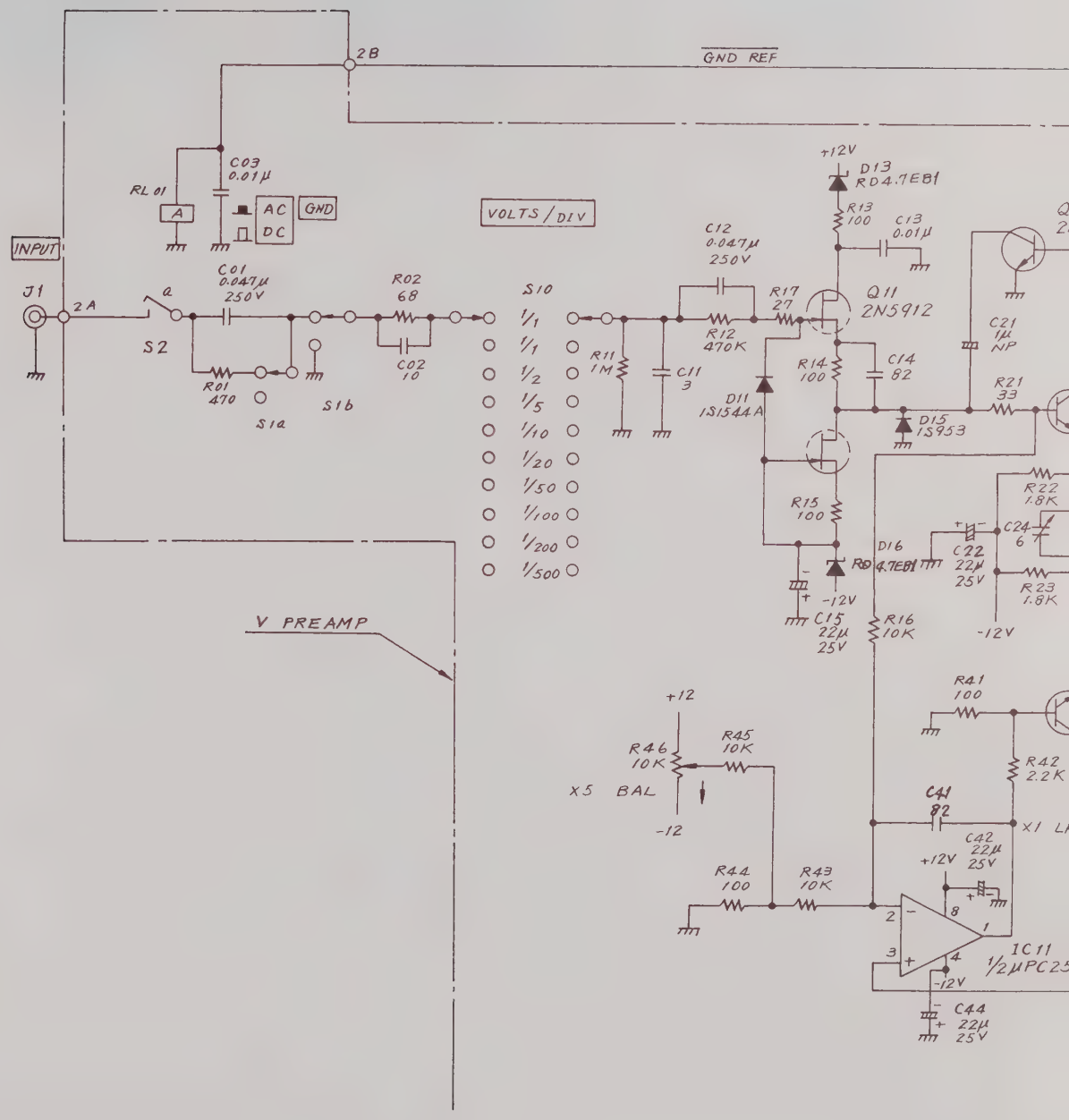

④
30mV
0V
0.2 mS

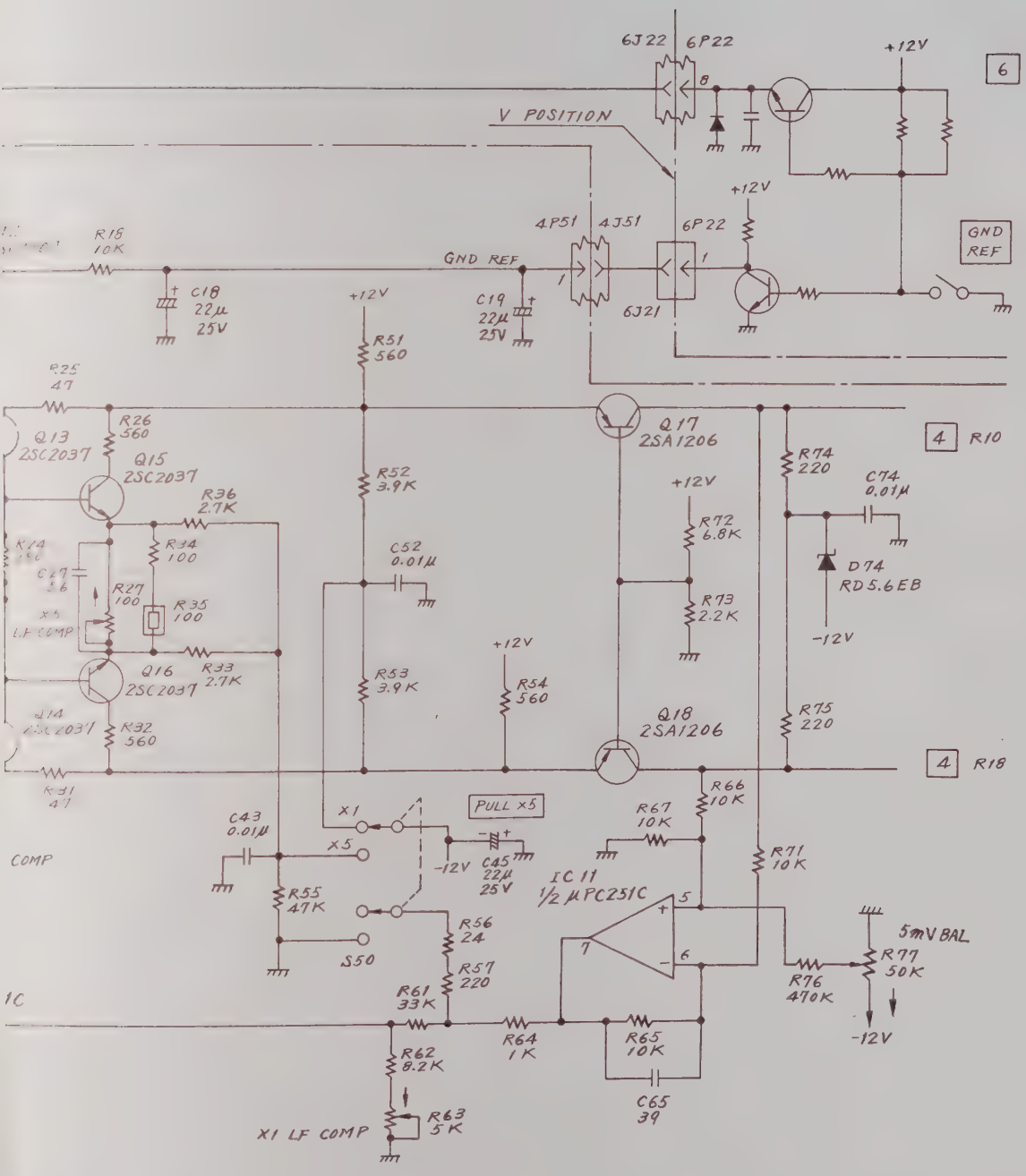

INPUT
J1
1A
1B
GND REF
S2
S1a
S1b
L01
C03 0.01μ
A
AC
DC
GND
C01 0.047μ 250V
R01 470
R02 68
C02 10
VOLTS/DIV
S10
1/1
1/2
1/5
1/10
1/20
1/50
1/100
1/200
1/500
V PREAMP
+12V
D13 RD4.7EB1
R13 100
C13 0.01μ
C12 0.047μ 250V
R17 27
Q11 2N5912
R12 470K
R11 1M
C11 6
0V
D11 1S1544A
R14 100
C14 82
C21 1μ NP
R21 33
D15 1S953
R15 100
C22 22μ 25V
D16 RD4.7EB1
-12V
C15 22μ 25V
R16 10K
R41 100
+12
R46 10K
R45 10K
X5 BAL
-12
C41 82
C42 22μ 25V
R44 100
R43 10K
+12V
-12V
C44 22μ 25V



SS-5711 / SS-5711C / SS-5711D
CH 1 ATTENUATOR
& PRE-AMPLIFIER (1) 1

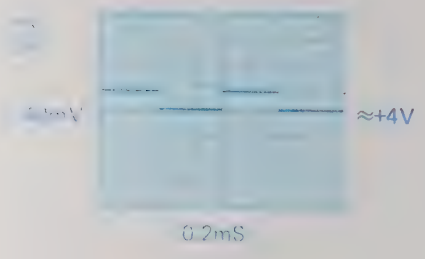
BBWSS24009102 4

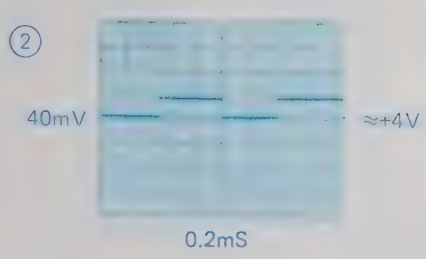

2B
GND REF
INPUT
J1
2A
S2
a
C01
0.047μ
250V
R01
470
S1a
S1b
R02
68
C02
10
RL01
A
C03
0.01μ
AC
DC
GND
VOLTS / DIV
S10
1/1
1/1
1/2
1/5
1/10
1/20
1/50
1/100
1/200
1/500
R11
1M
C11
3
C12
0.047μ
250V
R12
470K
R17
27
Q11
2N5912
+12V
D13
RD4.7EB1
R13
100
C13
0.01μ
C21
1μ
NP
R14
100
C14
82
D11
1S1544A
D15
1S953
R21
33
R15
100
D16
RD4.7EB1
-12V
C15
22μ
25V
R16
10K
R22
1.8K
C24
6
C22
22μ
25V
R23
1.8K
-12V
V PREAMP
+12
R46
10K
X5 BAL
R45
10K
-12
R41
100
R42
2.2K
C41
82
X1
C42
22μ
25V
+12V
R44
100
R43
10K
IC11
1/2μPC25
-12V
C44
22μ
25V

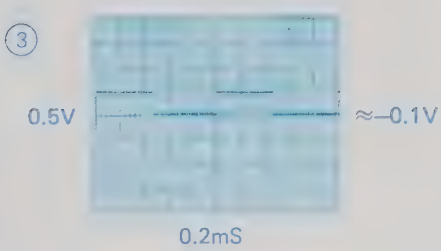


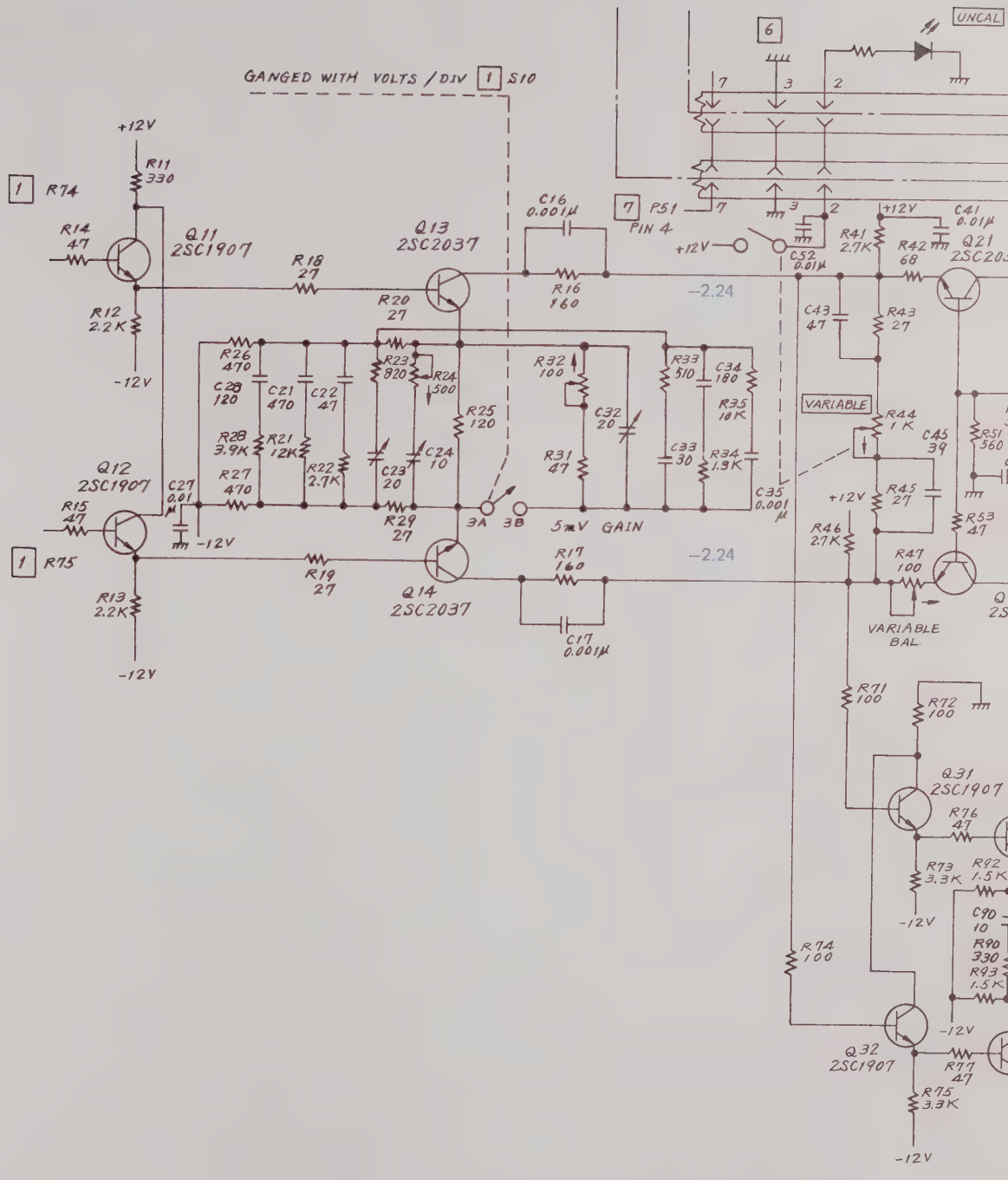
SS-5711/SS-5711C/SS-5711D
CH 2 ATTENUATOR & PRE-AMPLIFIER (1) 2

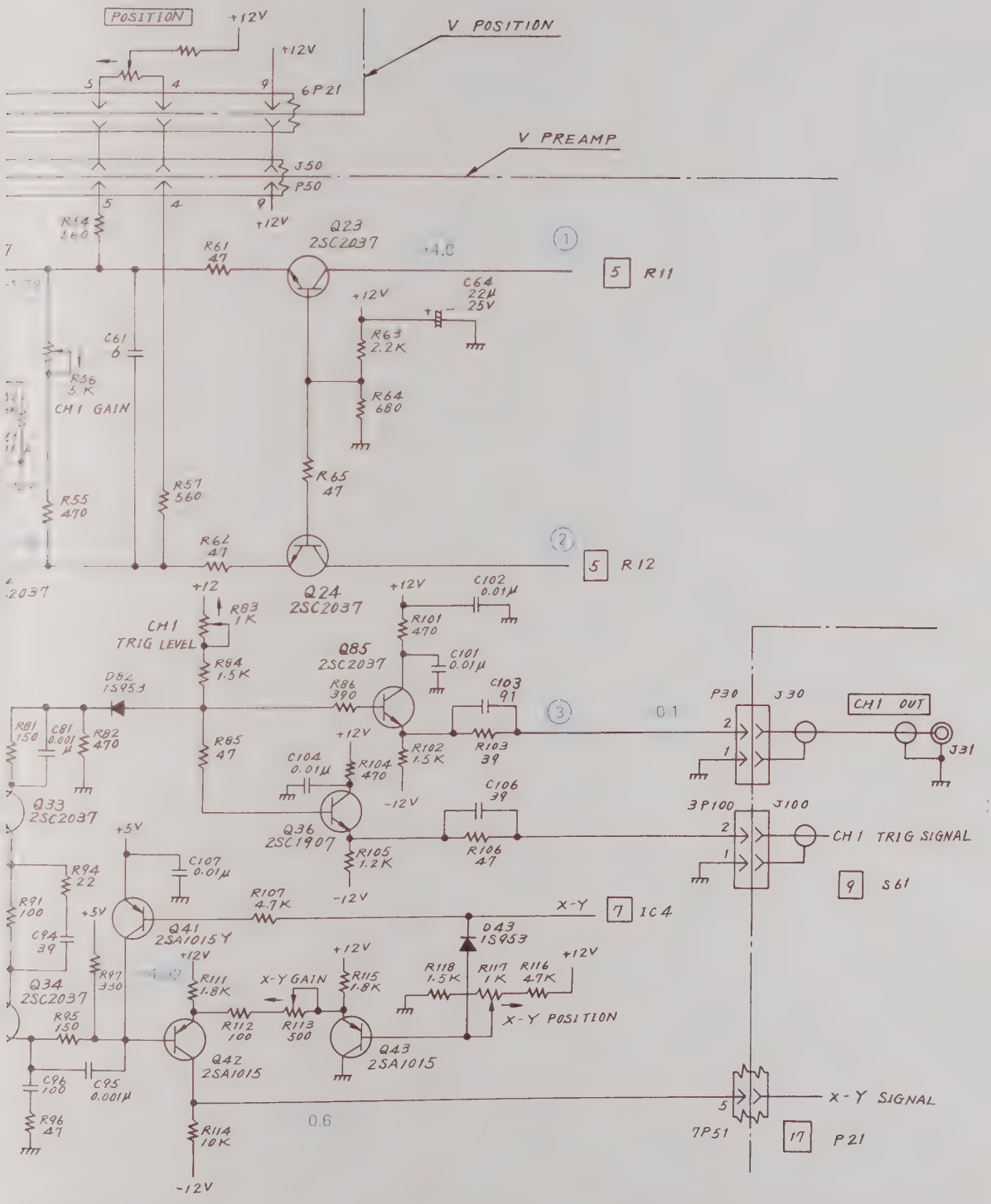
BBWSS24010102 4


≈+4V
0.2mS


②
40mV
≈+4V
0.2mS


③
0.5V
≈–0.1V
0.2mS

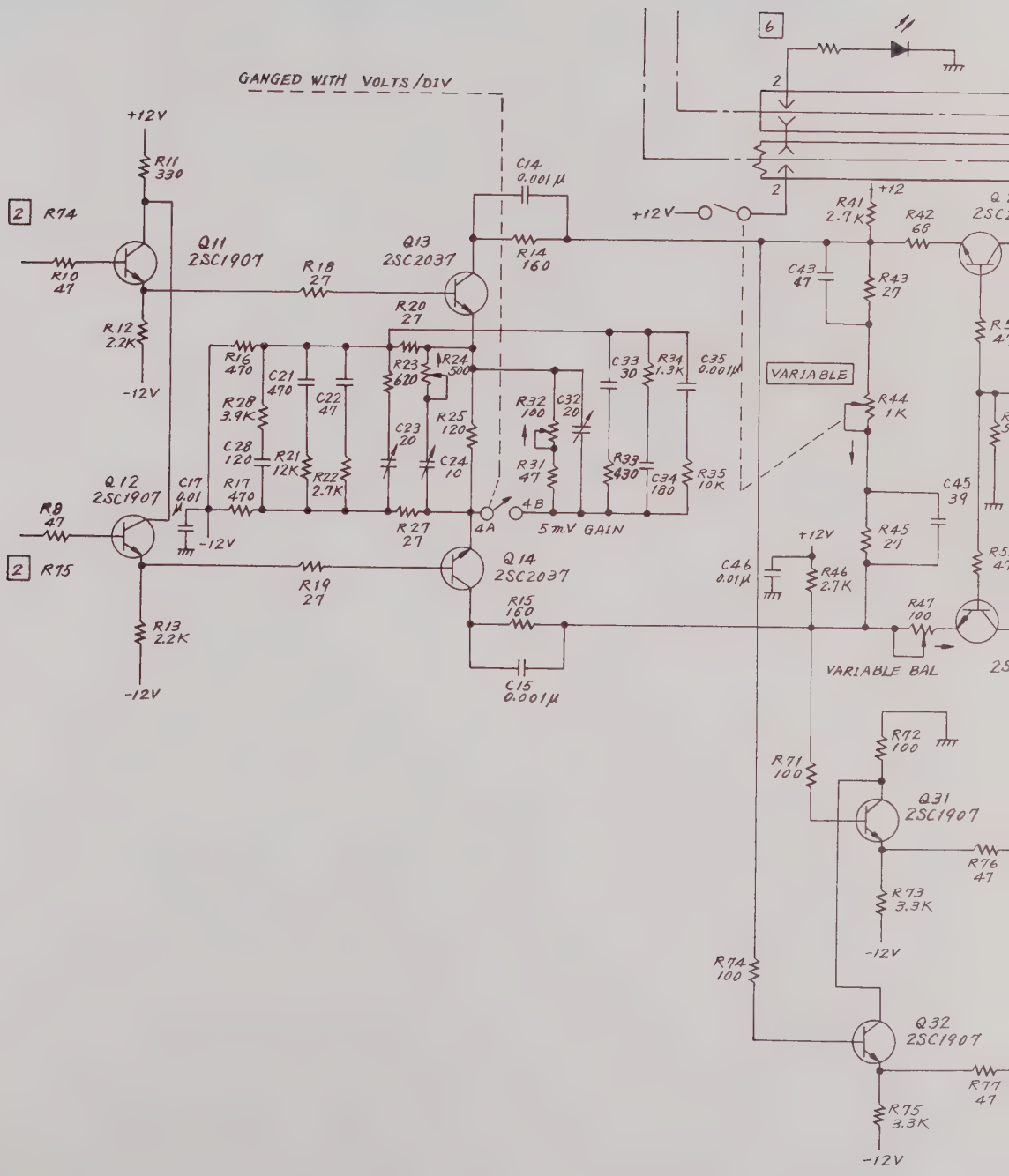

GANGED WITH VOLTS / DIV 1 S10
+12V
R11 330
1 R74
R14 47
Q11 2SC1907
R12 2.2K
-12V
R18 27
Q13 2SC2037
R20 27
C16 0.001μ
R16 160
7 P51 PIN 4
+12V
C52 0.01μ
-2.24
R26 470
C28 120
C21 470
C22 47
R23 820
R24 500
R25 120
R32 100
C32 20
R33 510
C34 180
R35 10K
R28 3.9K
R21 12K
R22 2.7K
C23 20
C24 10
R31 47
C33 30
R34 1.9K
C35 0.001μ
Q12 2SC1907
C27 0.01μ
R27 470
R15 47
R29 27
3A 3B
5mV GAIN
1 R75
R19 27
Q14 2SC2037
R17 160
C17 0.001μ
-2.24
R13 2.2K
-12V
6
UNCAL
7 3 2
+12V
C41 0.01μ
R41 2.7K
R42 68
Q21 2SC20
C43 47
R43 27
VARIABLE
R44 1K
C45 39
R51 560
+12V
R45 27
R53 47
R46 2.7K
R47 100
VARIABLE BAL.
R71 100
R72 100
Q31 2SC1907
R76 47
R73 3.3K
R92 1.5K
-12V
C90 10
R90 330
R93 1.5K
R74 100
-12V
Q32 2SC1907
R77 47
R75 3.3K
-12V

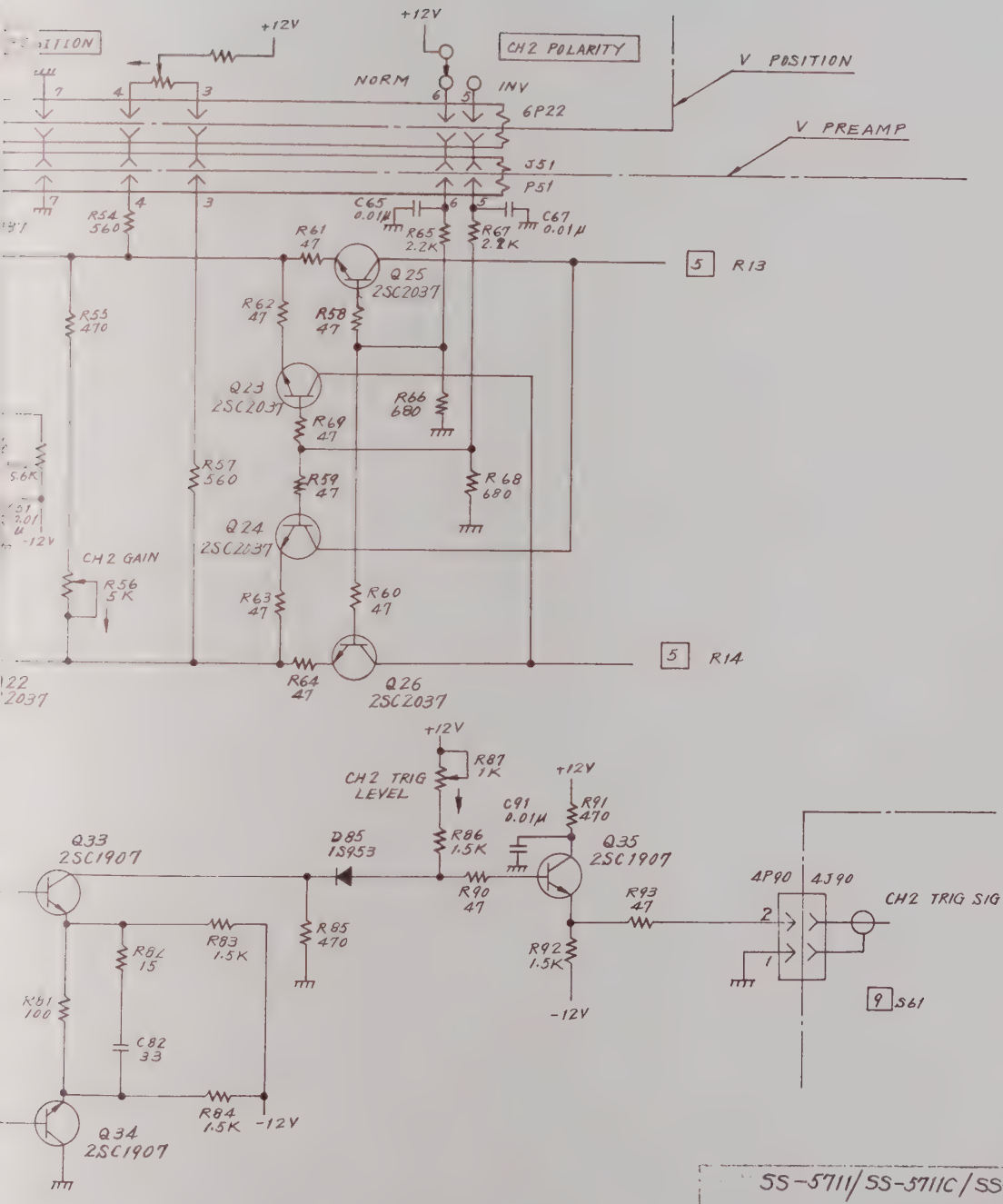


SS-5711 / SS-5711C / SS-5711D

CH1 PRE-AMPLIFIER(2) 3

BBWSS24011102 5

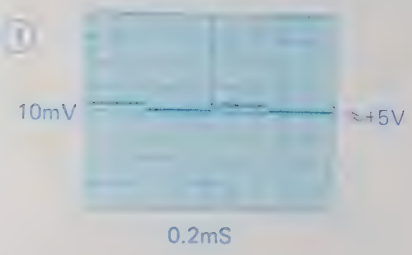

GANGED WITH VOLTS/DIV
+12V
R11 330
2 R74
Q11 2SC1907
R10 47
R12 2.2K
-12V
R18 27
Q13 2SC2037
C14 0.001μ
R14 160
R20 27
R16 470
C21 470
C22 47
R23 620
R24 500
R28 3.9K
C28 120
R21 12K
R22 2.7K
C23 20
C24 10
R25 120
C17 0.01μ
R17 470
R27 27
4A
4B
5mV GAIN
C33 30
R34 1.3K
C35 0.001μ
R32 100
C32 20
R31 47
R33 430
C34 180
R35 10K
Q12 2SC1907
R8 47
2 R15
Q14 2SC2037
R19 27
R15 160
R13 2.2K
C15 0.001μ
+12V
R41 2.7K
R42 68
C43 47
R43 27
VARIABLE
R44 1K
C45 39
R45 27
C46 0.01μ
R46 2.7K
R47 100
VARIABLE BAL
R72 100
R71 100
Q31 2SC1907
R76 47
R73 3.3K
R74 100
Q32 2SC1907
R77 47
R75 3.3K
6
2

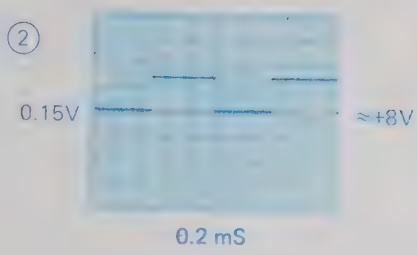


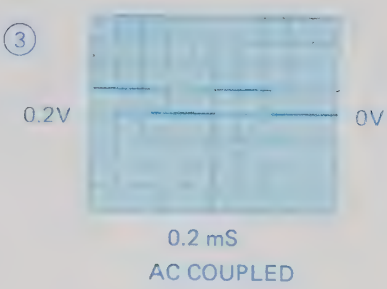
SS-5711/SS-5711C/SS-5711D

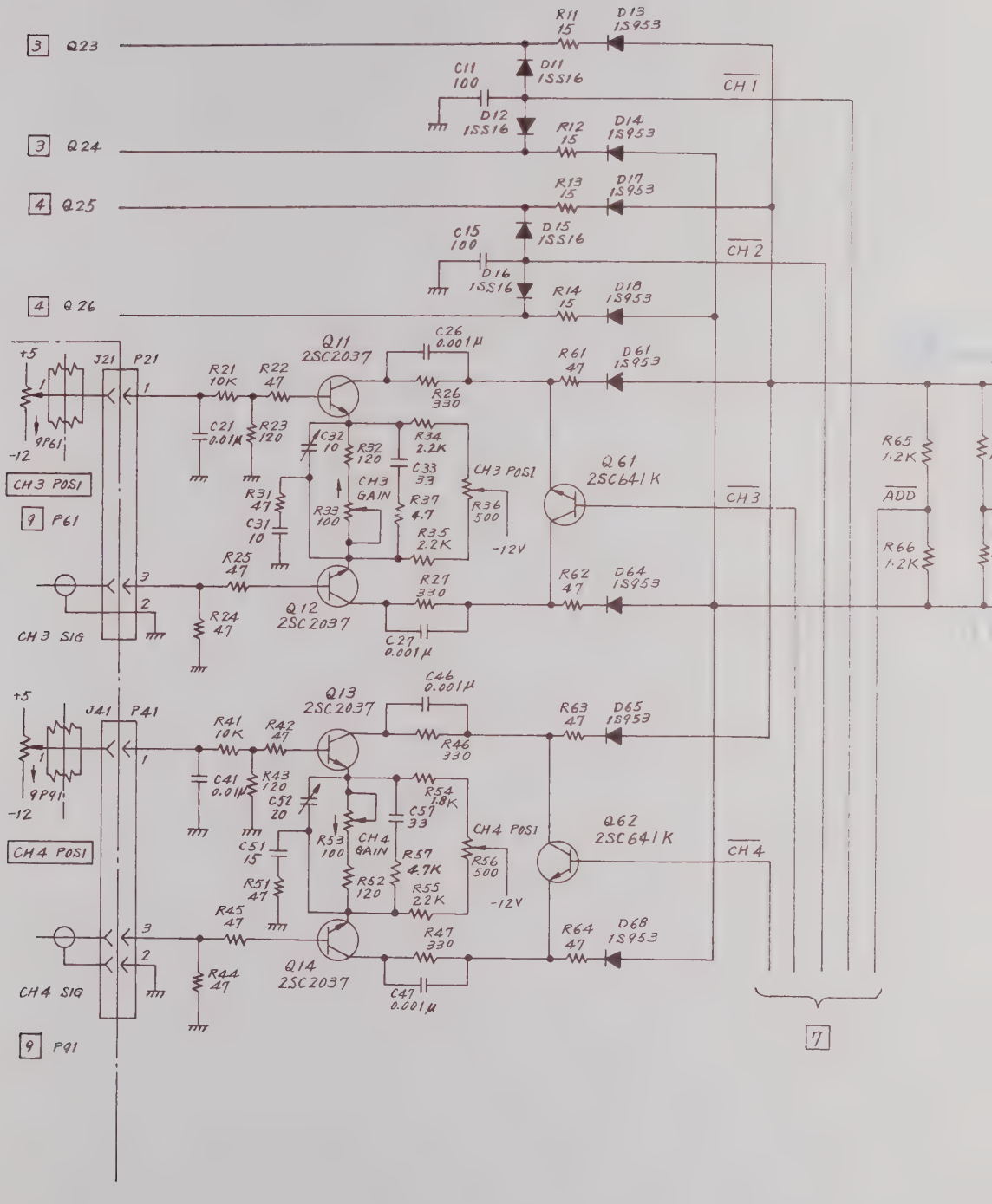
CH2 PRE-AMPLIFIER(2) 4

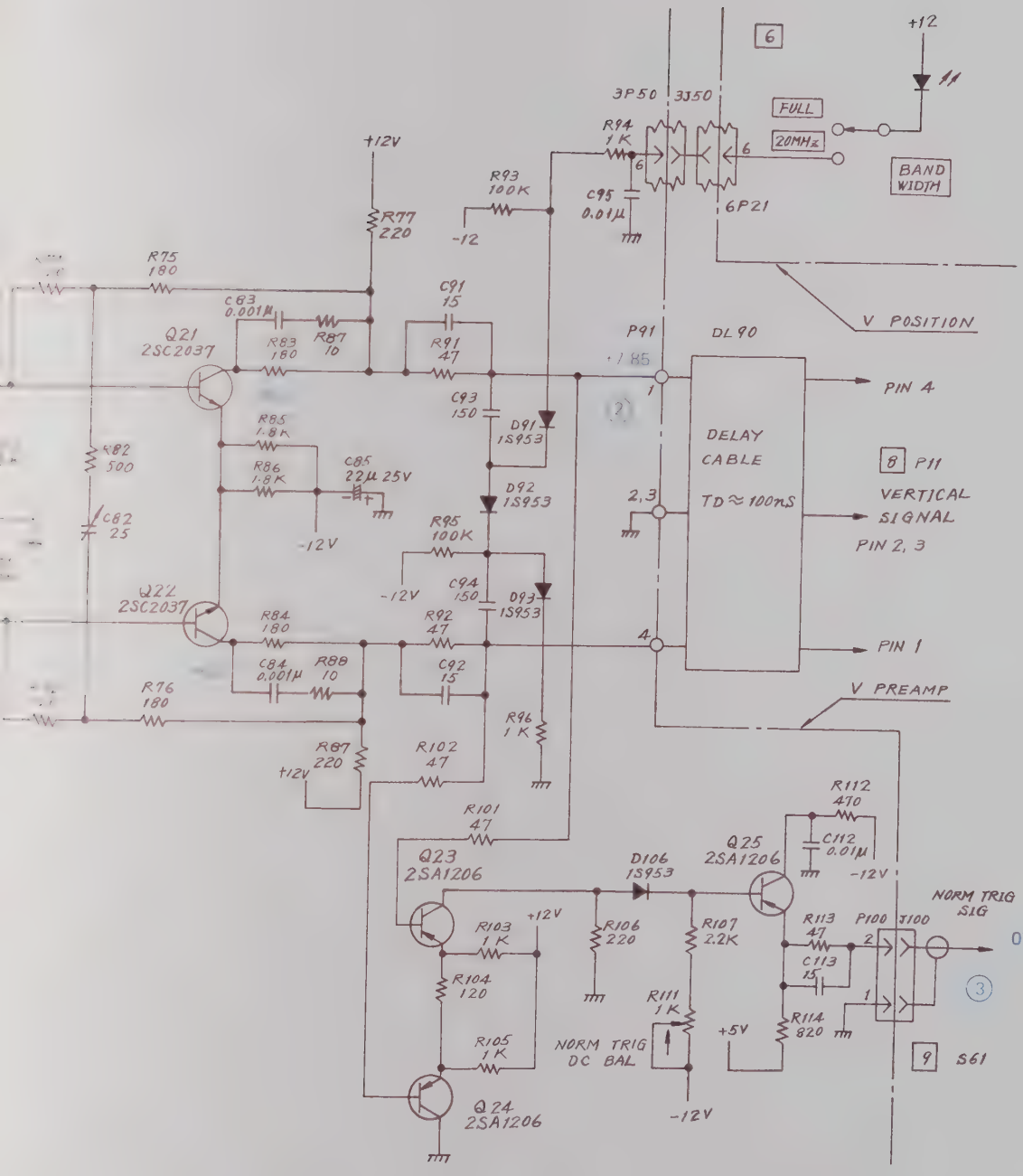
BBWSS24012102 4


①
10mV
≈+5V
0.2mS


②
0.15V
≈+8V
0.2 mS


③
0.2V
0V
0.2 mS
AC COUPLED

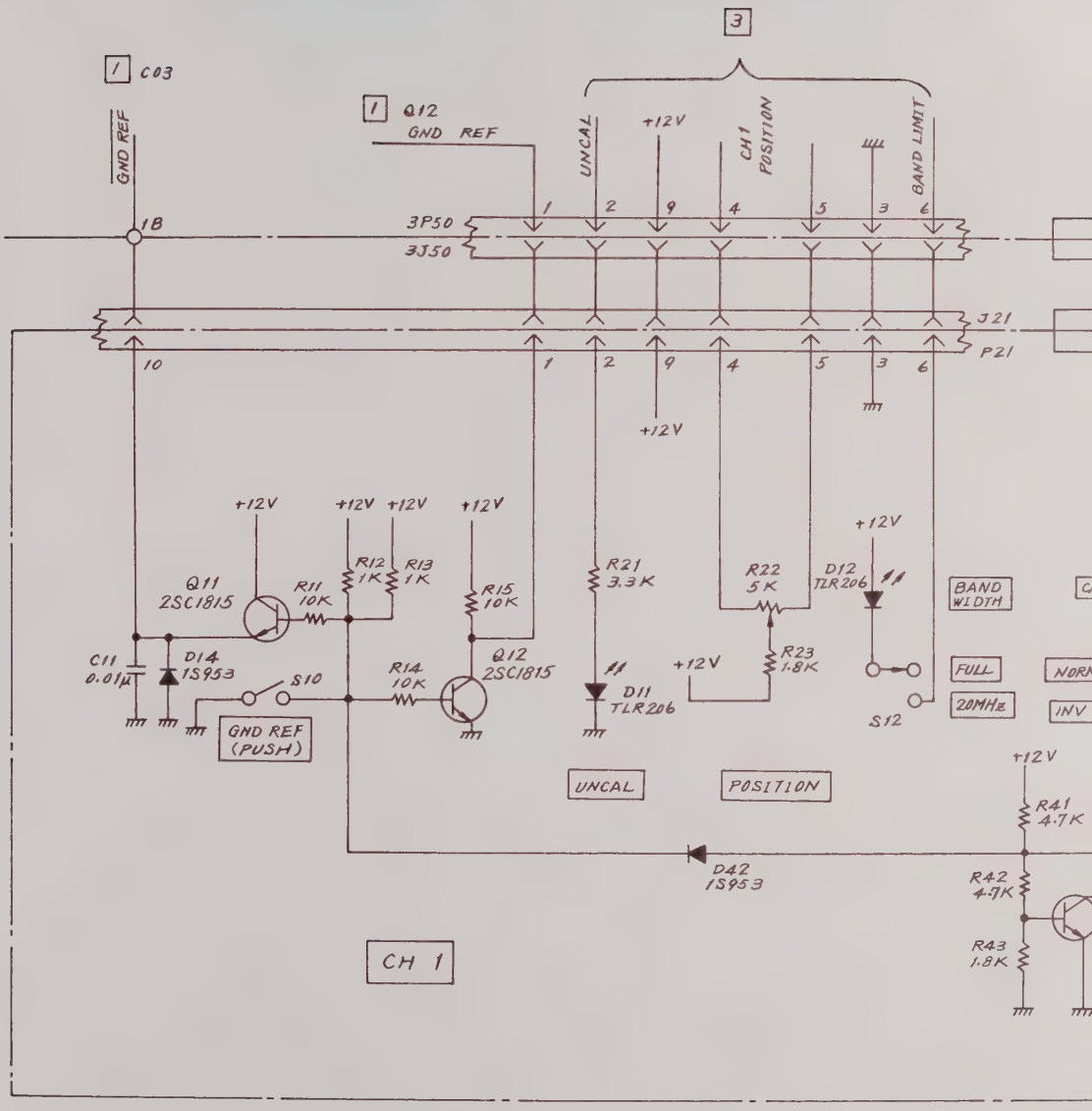

3 Q23
3 Q24
4 Q25
4 Q26
R11 15
D13 1S953
C11 100
D11 1SS16
D12 1SS16
R12 15
D14 1S953
R13 15
D17 1S953
C15 100
D15 1SS16
D16 1SS16
R14 15
D18 1S953
CH 1
CH 2
CH 3
CH 4
ADD
+5
-12
J21
P21
9P61
CH 3 POSI
9 P61
CH 3 SIG
R21 10K
R22 47
C21 0.01μ
R23 120
Q11 2SC2037
C26 0.001μ
R26 330
C32 10
R32 120
R34 2.2K
C33 33
CH3 GAIN
R33 100
R37 4.7
R36 500
CH3 POSI
R35 2.2K
-12V
R31 47
C31 10
R25 47
R24 47
Q12 2SC2037
R27 330
C27 0.001μ
R61 47
D61 1S953
Q61 2SC641K
R62 47
D64 1S953
R65 1.2K
R66 1.2K
J41
P41
9P91
CH 4 POSI
9 P91
CH 4 SIG
R41 10K
R42 47
C41 0.01μ
R43 120
Q13 2SC2037
C46 0.001μ
R46 330
C52 20
R54 1.8K
C51 15
C57 33
R53 100
CH4 GAIN
R57 4.7K
R56 500
CH4 POSI
R52 120
R55 2.2K
-12V
R51 47
R45 47
R44 47
Q14 2SC2037
R47 330
C47 0.001μ
R63 47
D65 1S953
Q62 2SC641K
R64 47
D68 1S953
7

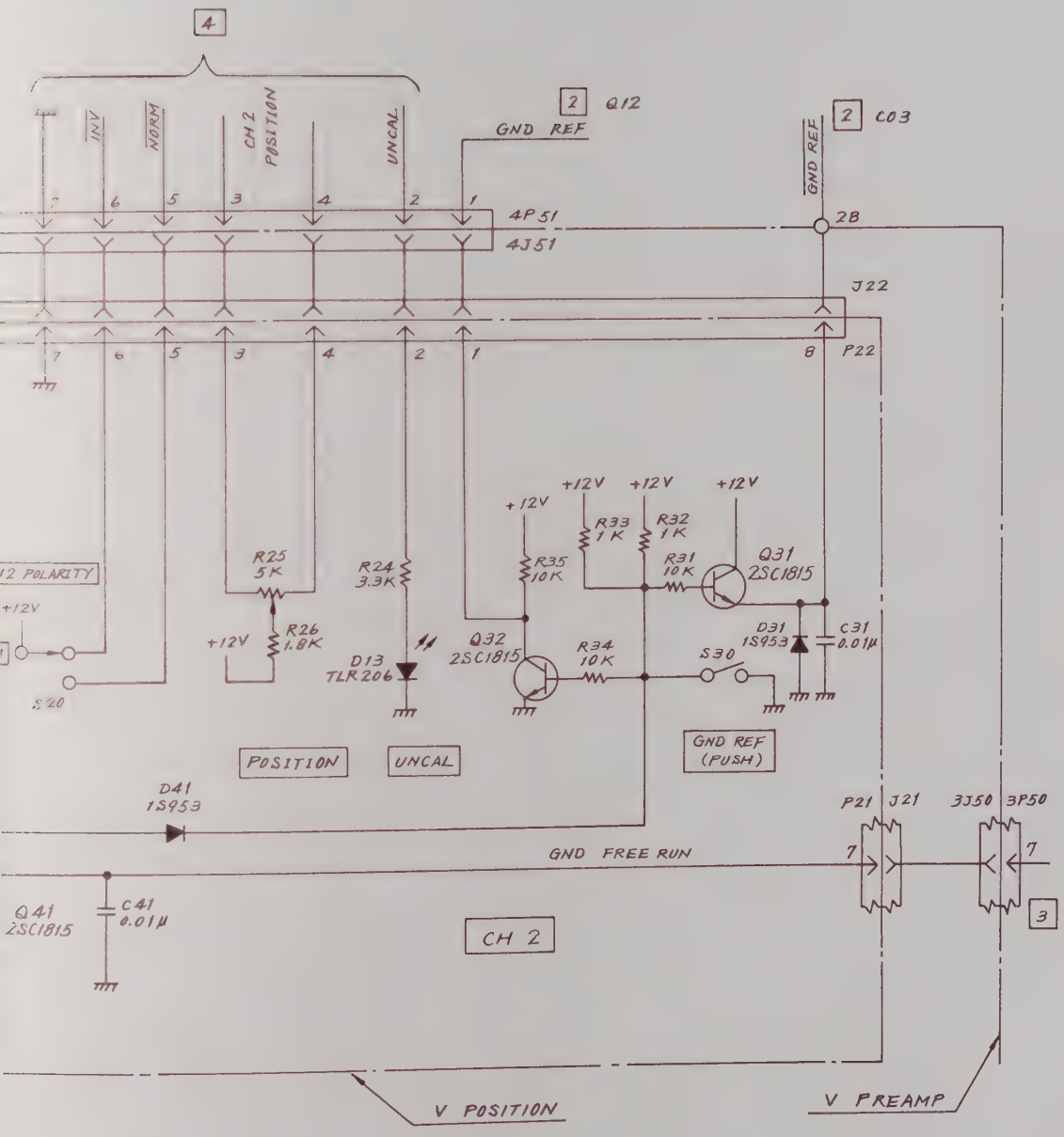


SS-5711 / SS-5711C / SS-5711D

DELAY CABLE DRIVER 5

BBWSS24013102 5

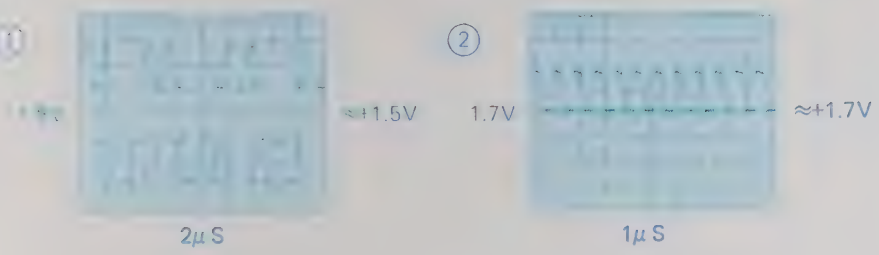

3
1 C03
1 Q12
GND REF
GND REF
UNCAL
+12V
CH1 POSITION
BAND LIMIT
1B
3P50
3J50
J21
P21
10
1
2
9
4
5
3
6
+12V
+12V
+12V
+12V
+12V
Q11 2SC1815
R11 10K
R12 1K
R13 1K
R15 10K
R21 3.3K
R22 5K
D12 TLR206
BAND WIDTH
C11 0.01μ
D14 1S953
S10
R14 10K
Q12 2SC1815
D11 TLR206
R23 1.8K
FULL
20MHz
S12
GND REF (PUSH)
UNCAL
POSITION
R41 4.7K
D42 1S953
R42 4.7K
R43 1.8K
CH 1

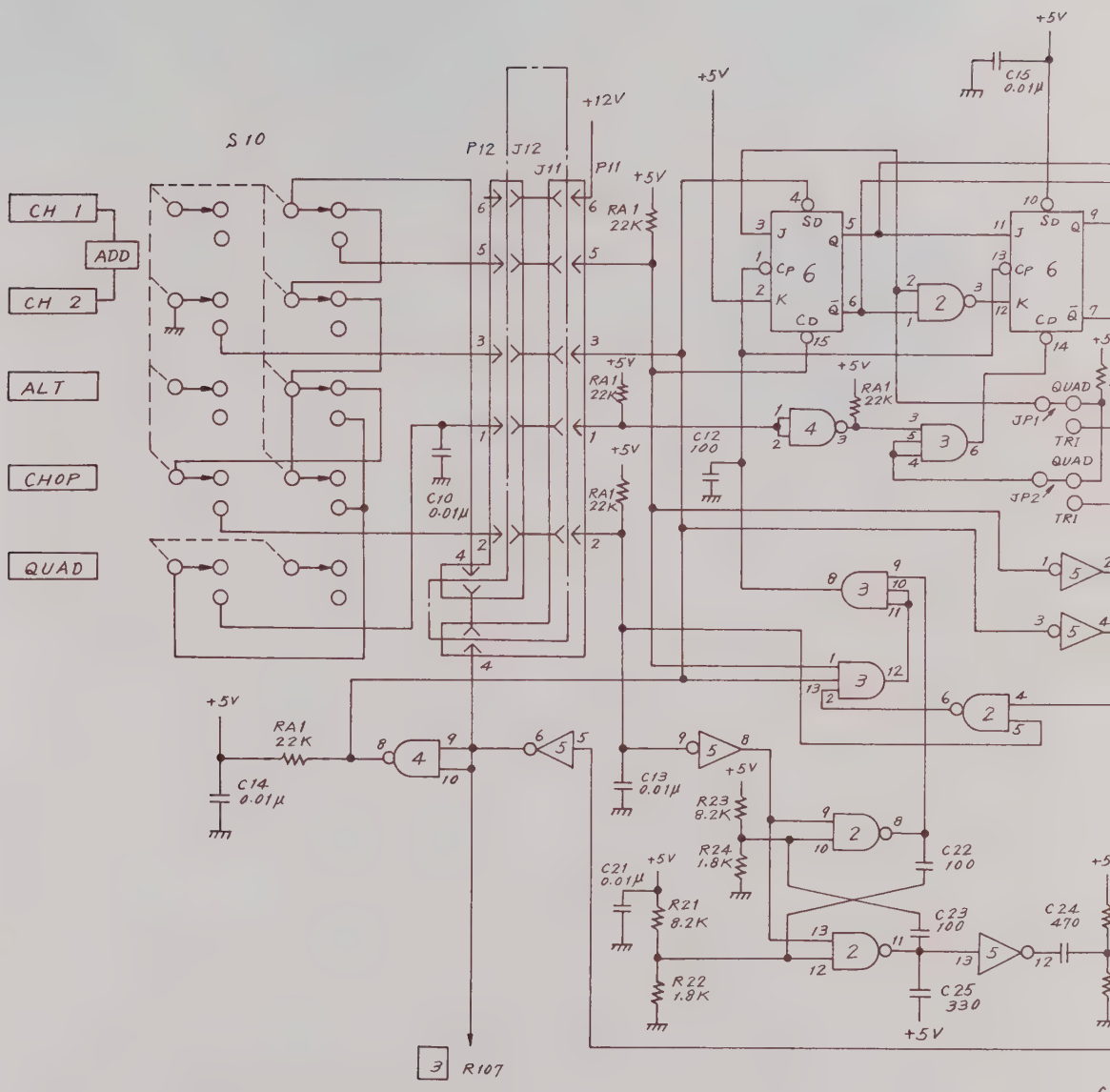


SS-5711 / SS-5711C / SS-5711D

VERTICAL PANEL SWITCHES 6

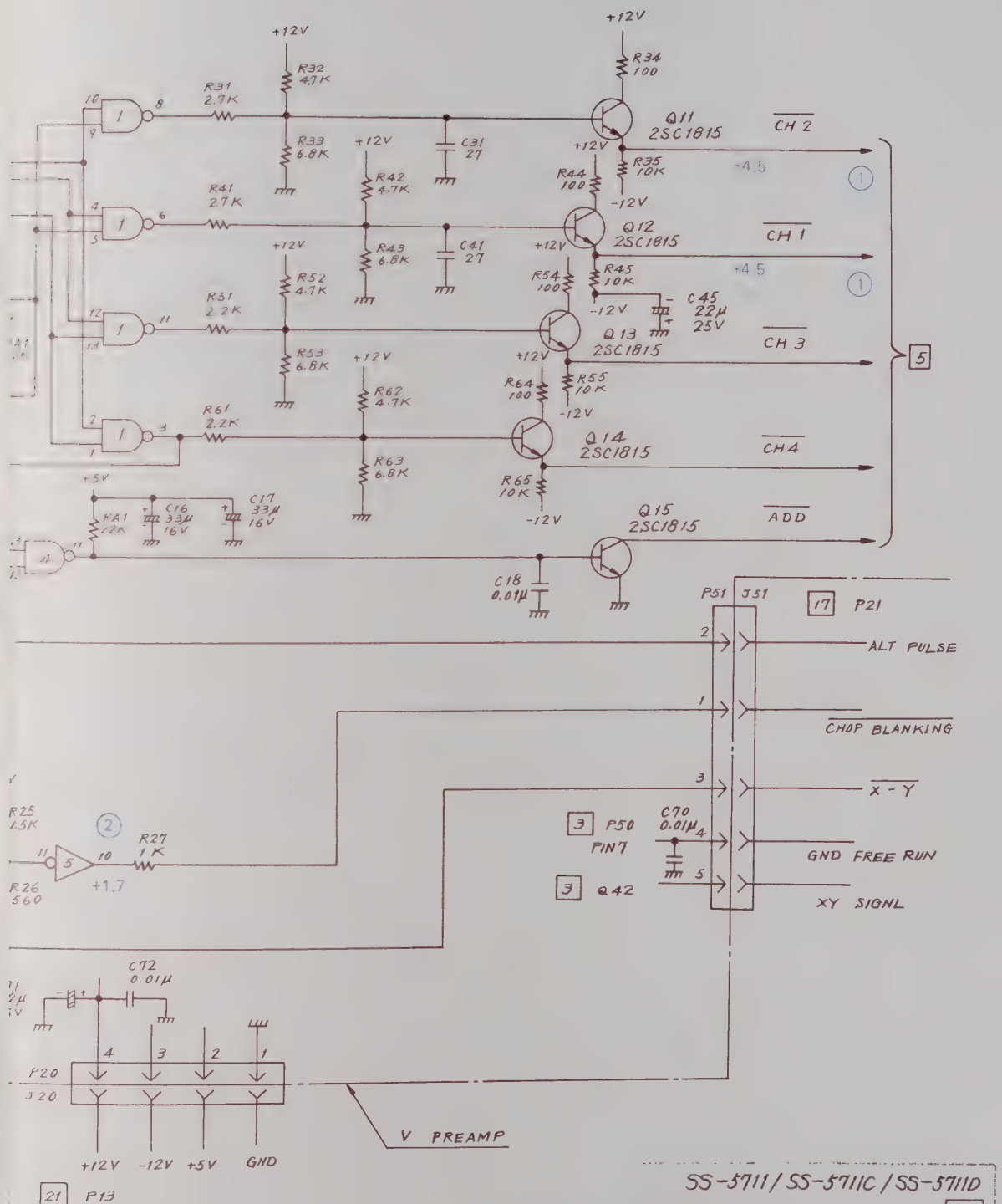
BBWSS40001102 3


①
≈+1.5V
2μS
②
1.7V
≈+1.7V
1μS



		GND	+5V
IC 2	74LS00	7	14
IC 5	74LS04	7	14
IC 3	74LS11	7	14
IC 4	74LS26	7	14
IC 1	74LS26	7	14
IC 6	74LS112	8	16

VOLTAGE & WAVEFORM READING CONDITIONS
MODE . . . . . CHOP



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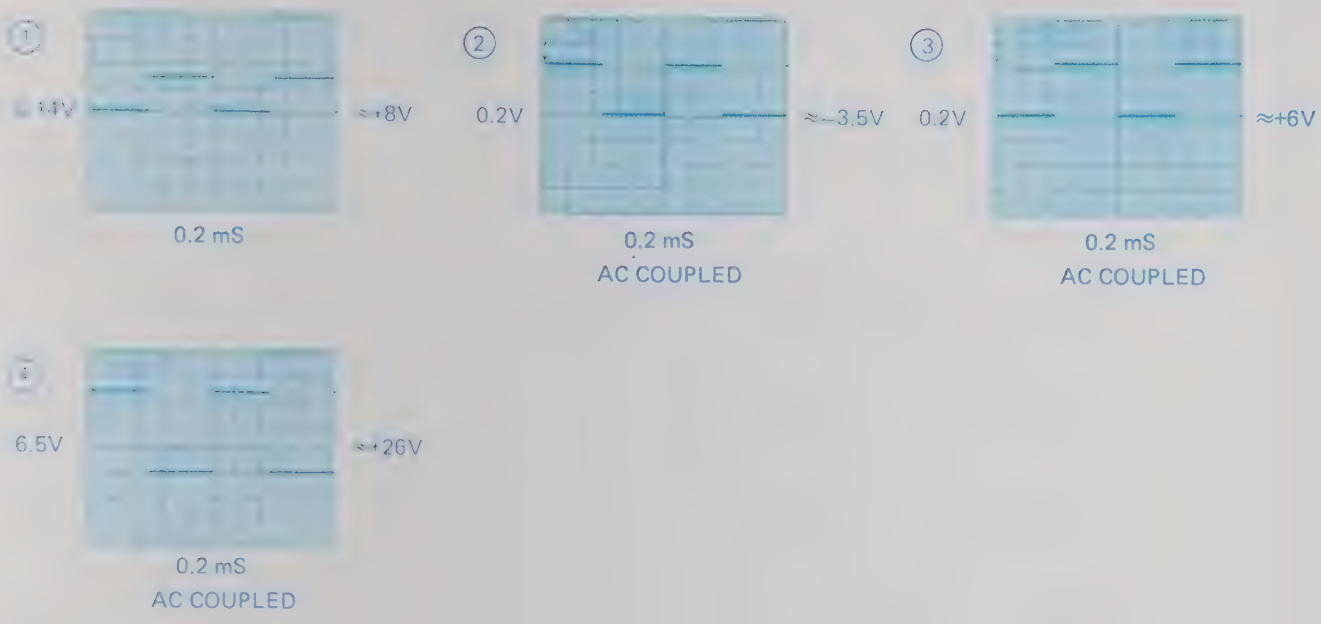
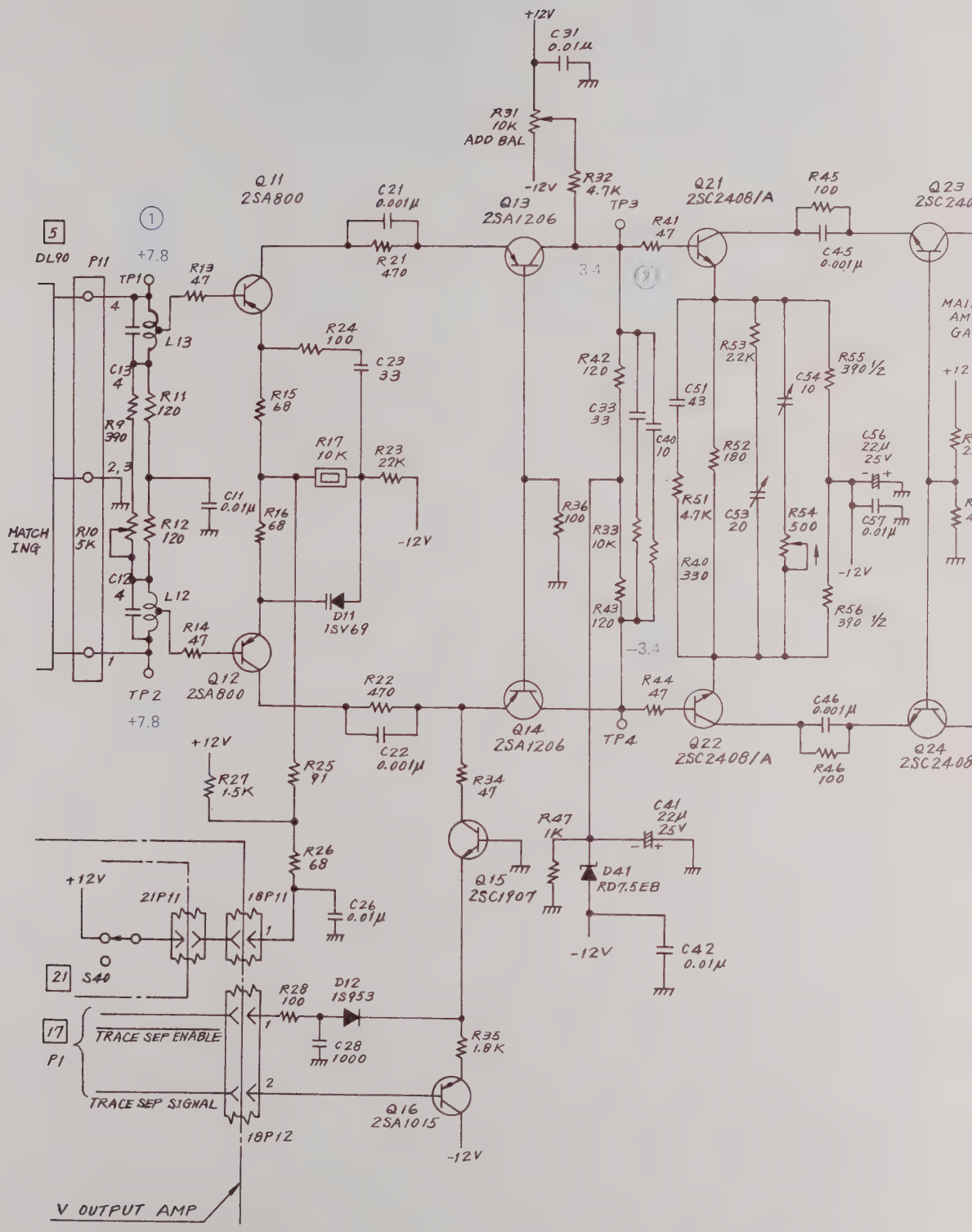
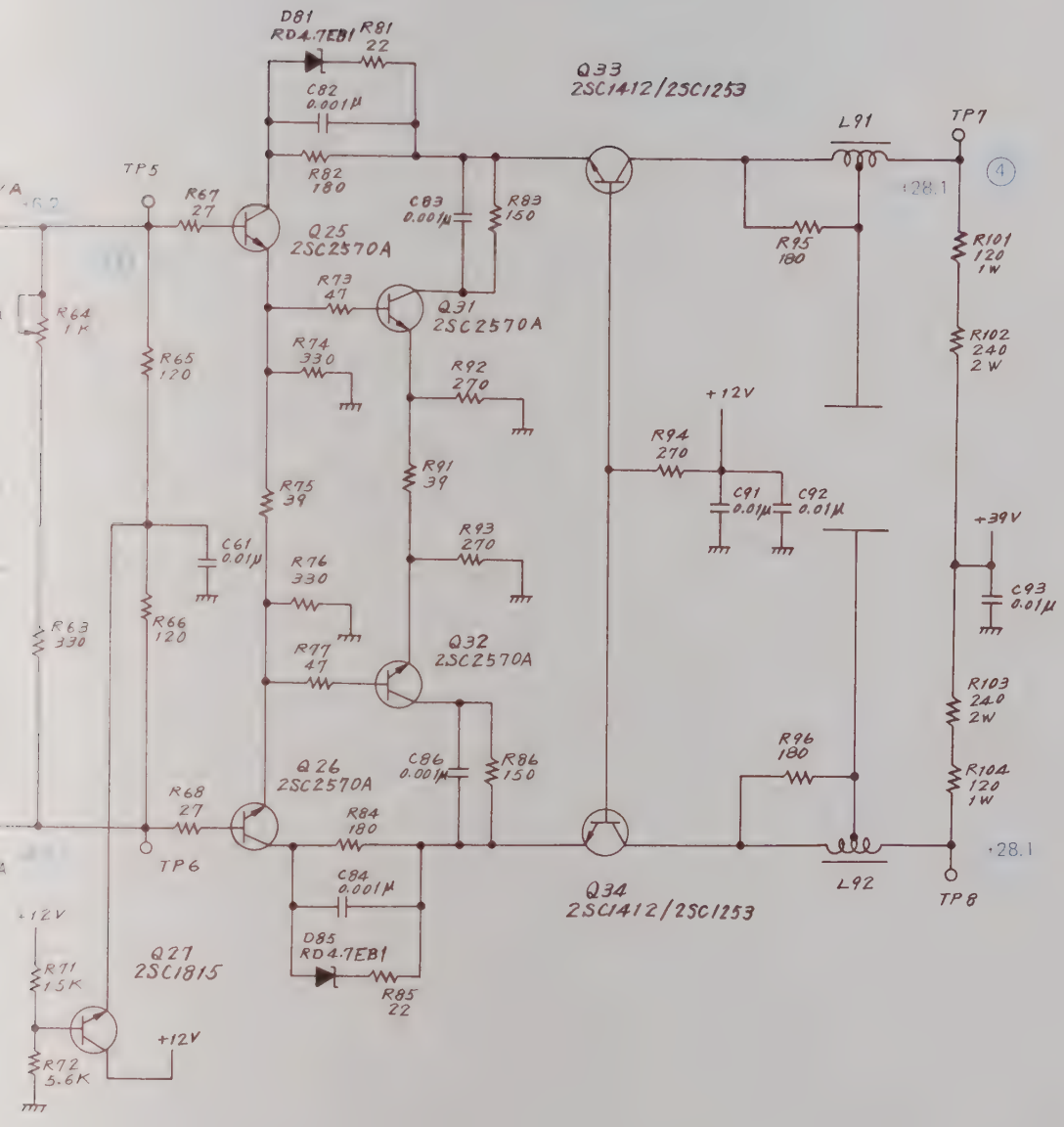
VERTICAL CONTROL 7

BBWSS10002102 3


1
1.4V
≈+8V
0.2 mS
2
0.2V
≈−3.5V
0.2 mS
AC COUPLED
3
0.2V
≈+6V
0.2 mS
AC COUPLED
4
6.5V
≈+26V
0.2 mS
AC COUPLED


+12V
C31 0.01μ
R31 10K ADD BAL
-12V
R32 4.7K
TP3
Q11 2SA800
C21 0.001μ
R21 470
Q13 2SA1206
Q21 2SC2408/A
R45 100
C45 0.001μ
Q23 2SC240
R41 47
5
DL90
P11
+7.8
TP1
R13 47
L13
C13 4
R11 120
R9 390
2,3
MATCH ING
R10 5K
R12 120
C12 4
L12
R14 47
Q12 2SA800
TP2
+7.8
C11 0.01μ
R24 100
C23 33
R15 68
R17 10K
R23 22K
-12V
R16 68
D11 1SV69
R42 120
C33 33
C40 10
R53 2.2K
C51 43
R52 180
R51 4.7K
C53 20
C54 10
R55 390 ½
C56 22μ 25V
C57 0.01μ
R54 500
R40 330
R36 100
R33 10K
R43 120
R56 390 ½
R22 470
C22 0.001μ
Q14 2SA1206
TP4
R44 47
Q22 2SC2408/A
C46 0.001μ
R46 100
Q24 2SC2408
+12V
R27 1.5K
R25 91
R34 47
R47 1K
C41 22μ 25V
D41 RD7.5EB
Q15 2SC1907
-12V
C42 0.01μ
R26 68
+12V
21P11
18P11
C26 0.01μ
21
S40
17
P1
TRACE SEP ENABLE
TRACE SEP SIGNAL
R28 100
D12 1S953
C28 1000
R35 1.8K
Q16 2SA1015
18P12
-12V
V OUTPUT AMP



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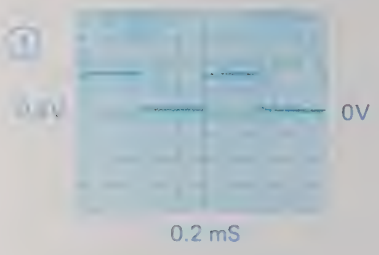
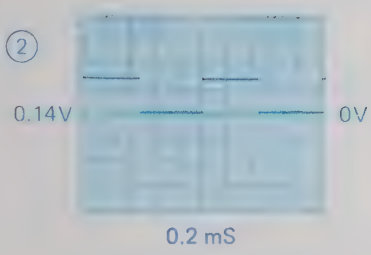
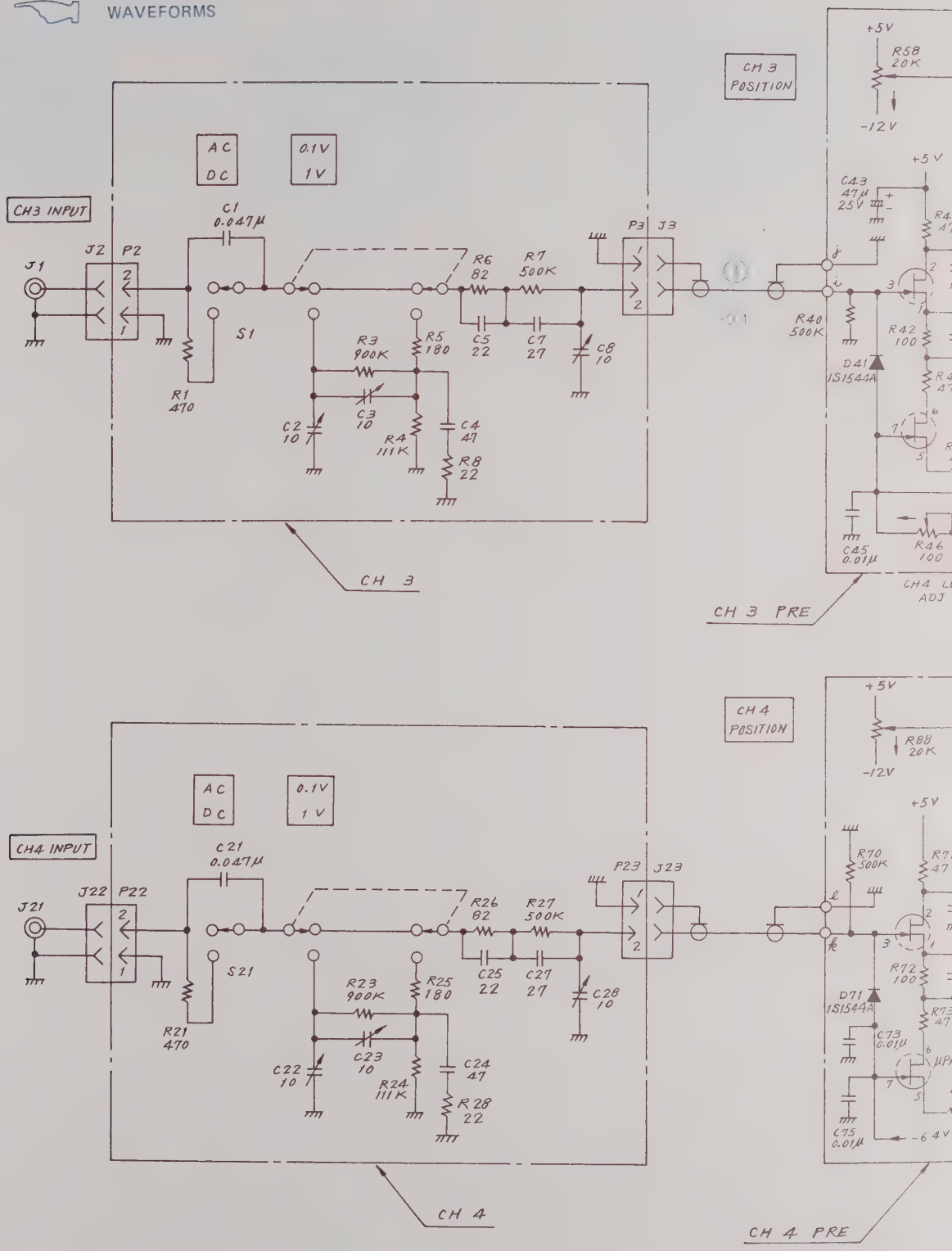
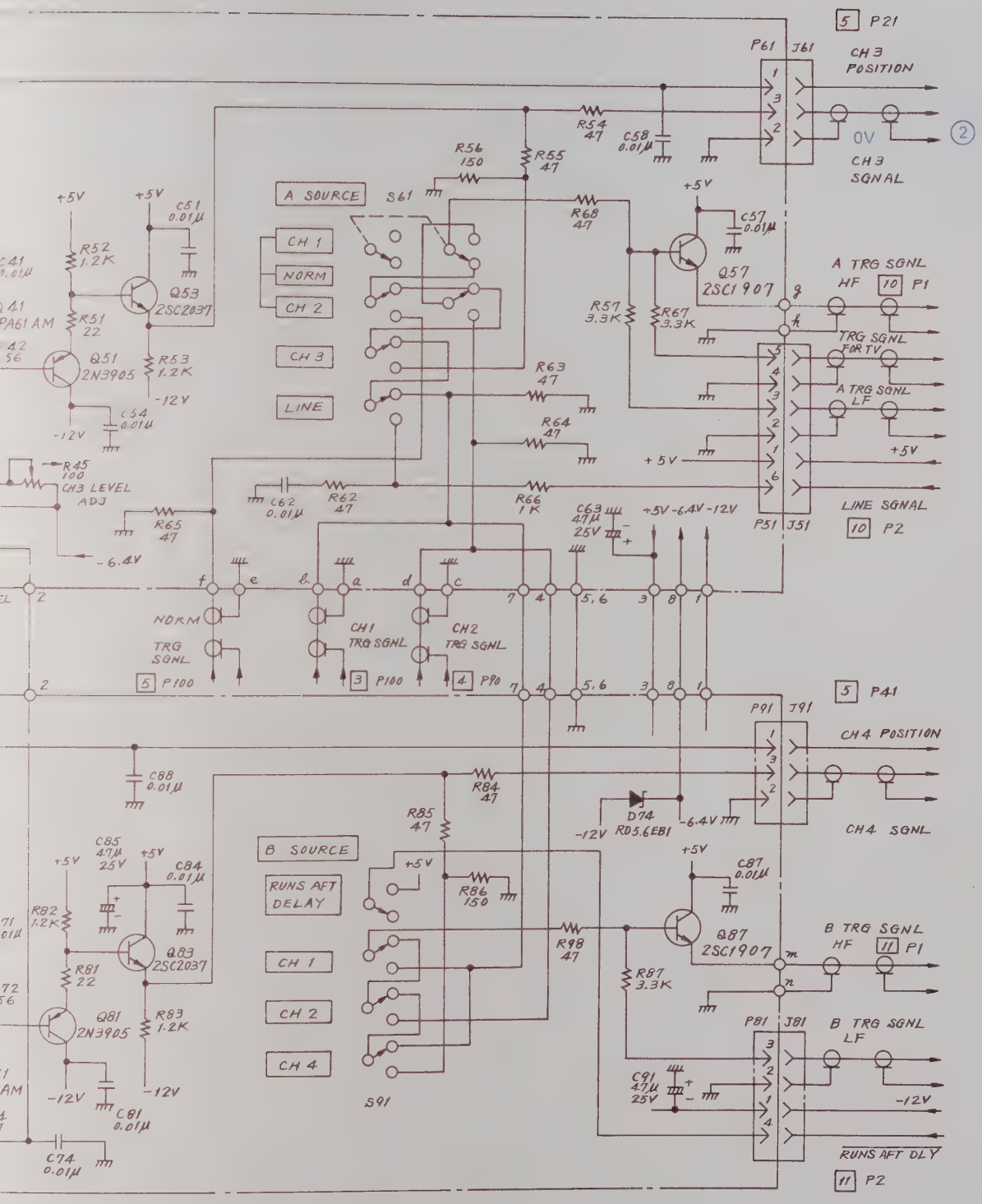
VERTICAL OUTPUT AMPLIFIER 8

BBWSS24014102 5


①
0.8V
0V
0.2 mS


②
0.14V
0V
0.2 mS


CH3 INPUT
J1
J2
P2
AC
DC
0.1V
1V
C1
0.047μ
S1
R1
470
R3
900K
R5
180
R6
82
R7
500K
C2
10
C3
10
R4
111K
C4
47
R8
22
C5
22
C7
27
C8
10
P3
J3
CH 3
CH 3 POSITION
+5V
R58
20K
-12V
C43
47μ
25V
R40
500K
D41
1S1544A
R42
100
C45
0.01μ
R46
100
CH 3 PRE
CH4 INPUT
J21
J22
P22
C21
0.047μ
S21
R21
470
R23
900K
R25
180
R26
82
R27
500K
C22
10
C23
10
R24
111K
C24
47
R28
22
C25
22
C27
27
C28
10
P23
J23
CH 4
CH 4 POSITION
R88
20K
R70
500K
D71
1S1544A
C73
0.01μ
C75
0.01μ
-6.4V
CH 4 PRE



VOLTAGE & WAVEFORM READING CONDITONS

MODE . . . . . .CHOP & QUAD

A SOURCE . . . . . .CH 3

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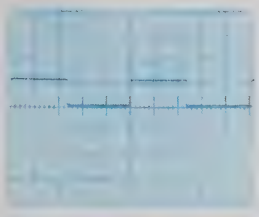
CH3 & CH4 PRE-AMPLIFIER & SOURCE 9

BBWSS24015102 3

① 0.7V 0V

0.2 mS

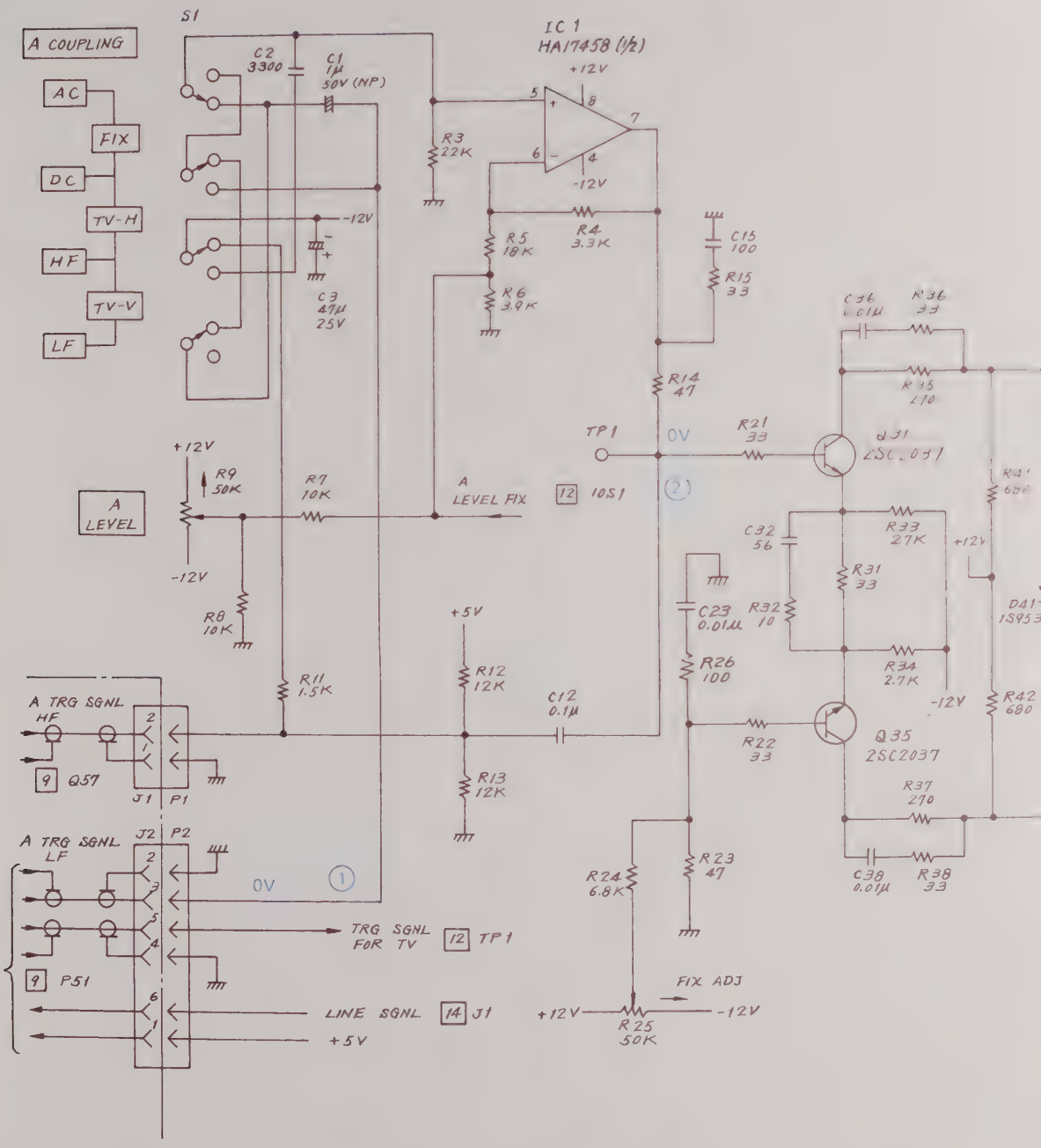
② 0.2V 0V

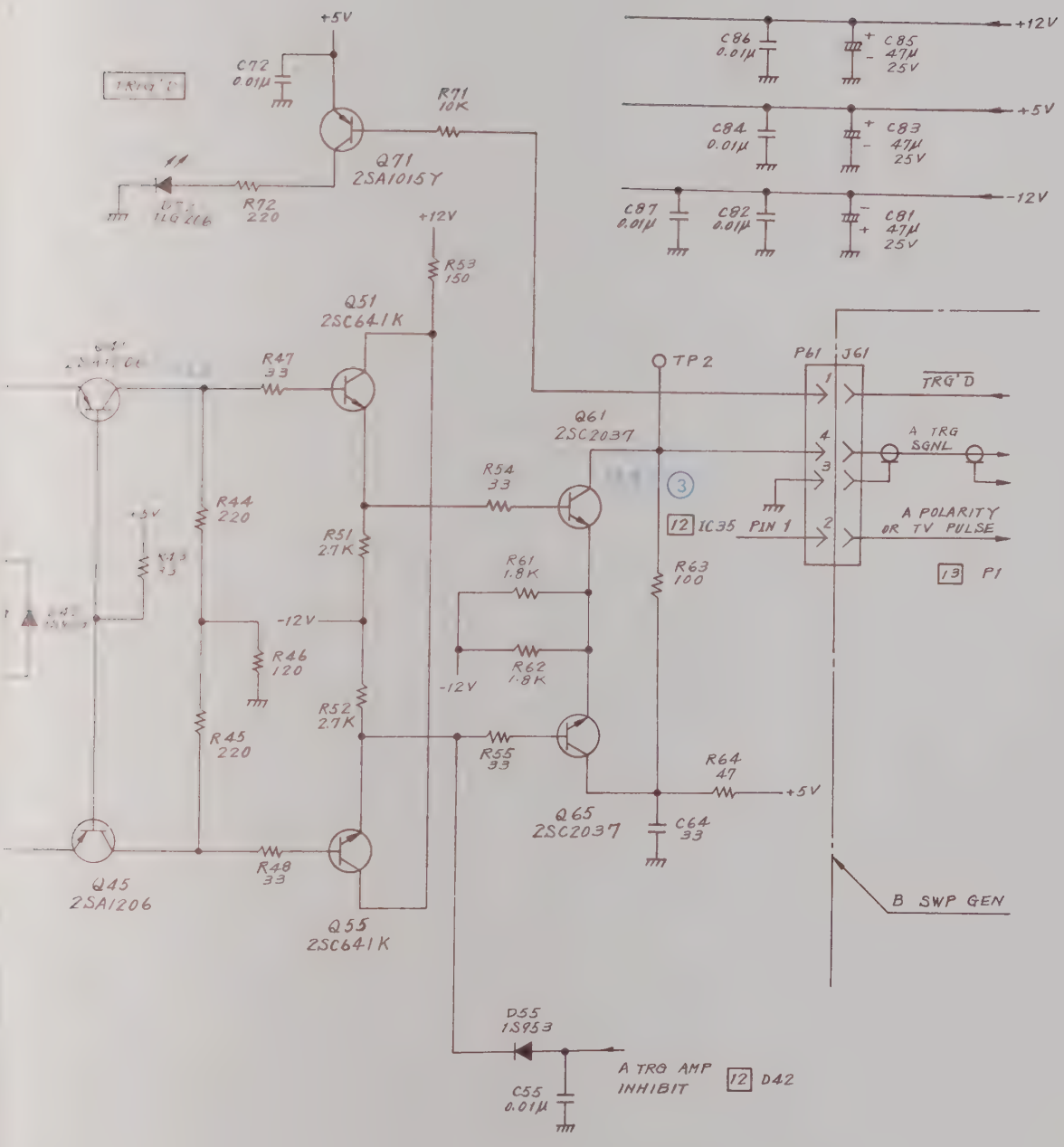


0.2 mS

③ 1.3V ≈+3V

0.2 mS


A COUPLING
AC
FIX
DC
TV-H
HF
TV-V
LF
S1
C2 3300
C1 1μ 50V (NP)
-12V
C3 47μ 25V
IC 1 HA17458 (1/2)
+12V
-12V
R3 22K
R4 3.3K
R5 18K
R6 3.9K
C15 100
R15 33
R14 47
TP1
0V
R21 33
Q31 2SC_0?1
C36 0.01μ
R36 33
R35 270
R41 680
C32 56
R33 27K
R31 33
C23 0.01μ
R32 10
R26 100
R34 2.7K
R42 680
Q35 2SC2037
R22 33
R37 270
C38 0.01μ
R38 33
R23 47
R24 6.8K
FIX ADJ
R25 50K
A LEVEL
R9 50K
R7 10K
R8 10K
R11 1.5K
A LEVEL FIX
12 10S1
(2)
+5V
R12 12K
R13 12K
C12 0.1μ
A TRG SGNL HF
9 Q57
J1 P1
A TRG SGNL LF
J2 P2
(1)
TRG SGNL FOR TV
12 TP1
9 P51
LINE SGNL
14 J1
+5V



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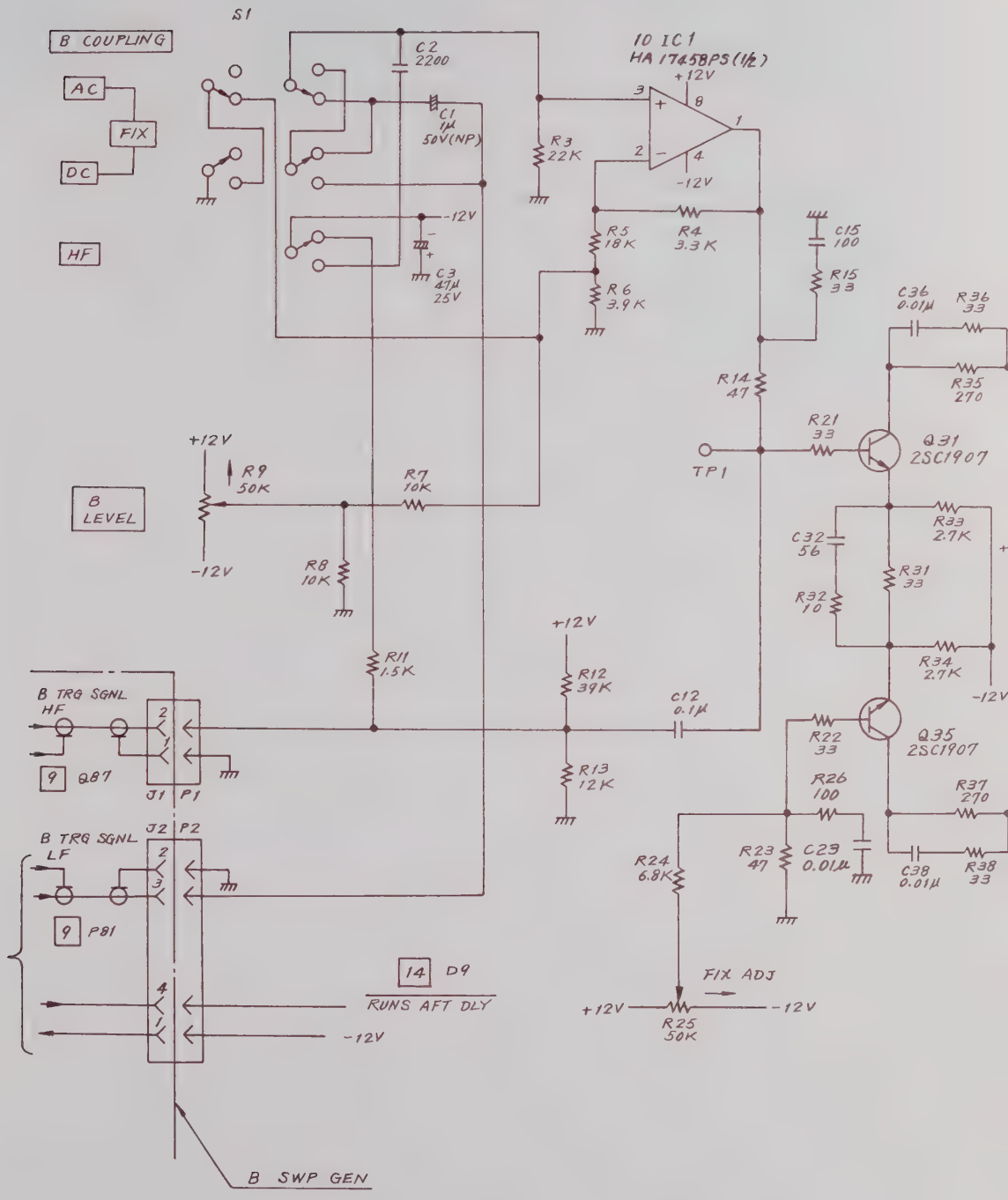
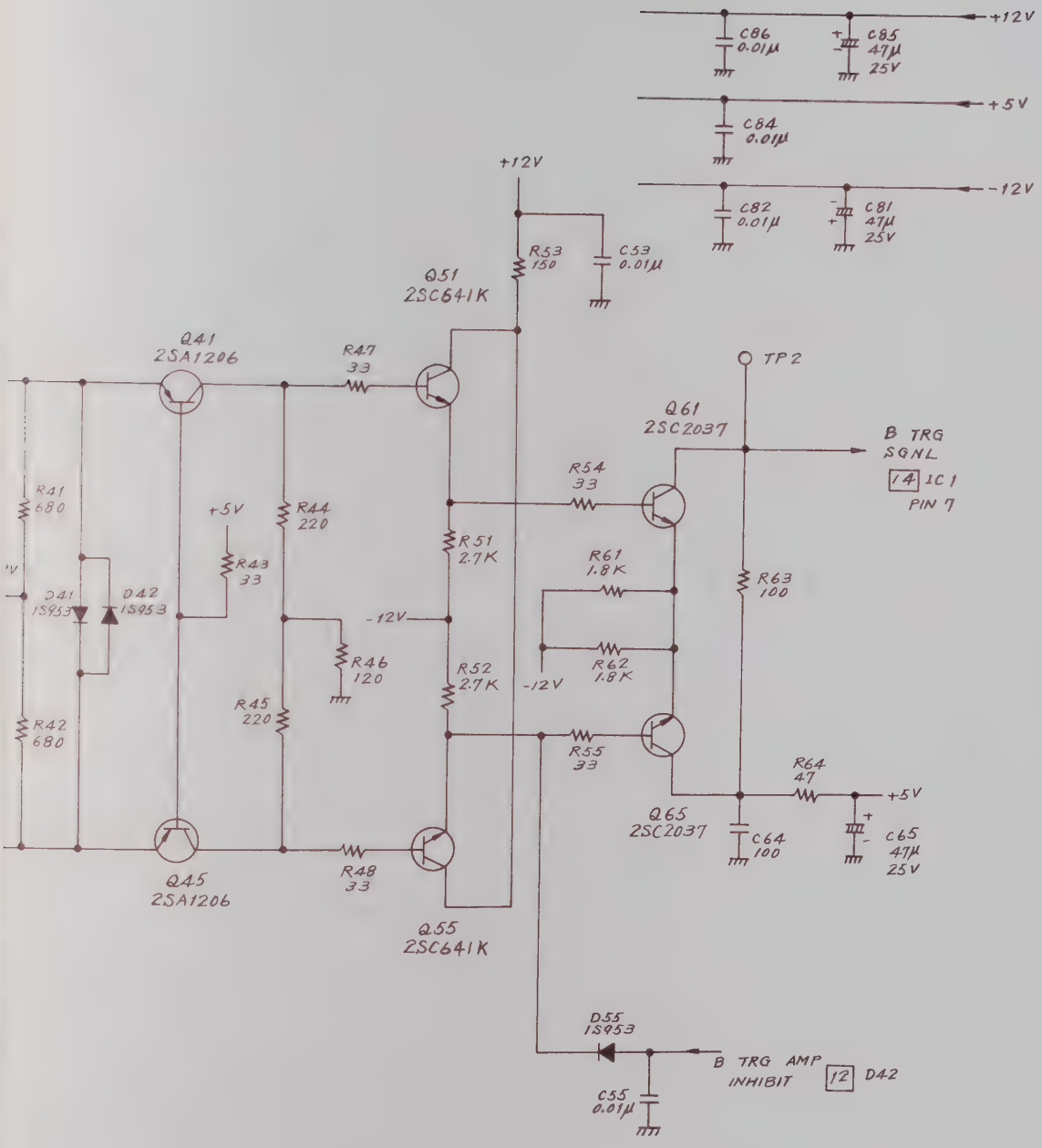
SS-5781

A TRIGGER AMPLIFIER 10

BBWSS34001102 5


B COUPLING
AC
FIX
DC
HF
S1
C2 2200
C1 1μ 50V(NP)
C3 47μ 25V
-12V
10 IC1
HA 1745BPS(1/2)
+12V
-12V
R3 22K
R4 3.3K
R5 18K
R6 3.9K
C15 100
R15 33
C36 0.01μ
R36 33
R35 270
R14 47
TP1
R21 33
Q31 2SC1907
R33 2.7K
C32 56
R31 33
R32 10
R34 2.7K
B LEVEL
R9 50K
R7 10K
R8 10K
R11 1.5K
R12 39K
R13 12K
C12 0.1μ
B TRG SGNL HF
9 Q87
J1 P1
B TRG SGNL LF
J2 P2
9 P81
14 D9
RUNS AFT DLY
R22 33
Q35 2SC1907
R26 100
R37 270
R24 6.8K
R23 47
C29 0.01μ
C38 0.01μ
R38 33
FIX ADJ
R25 50K
B SWP GEN



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SS-5784

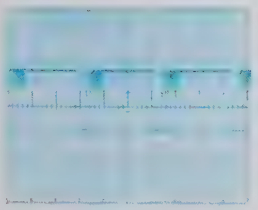
B TRIGGER AMPLIFIER 11

BBWSS34002102 6

① 0.15V 0V

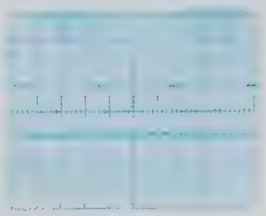
20μ S

② 5V ≈+5V

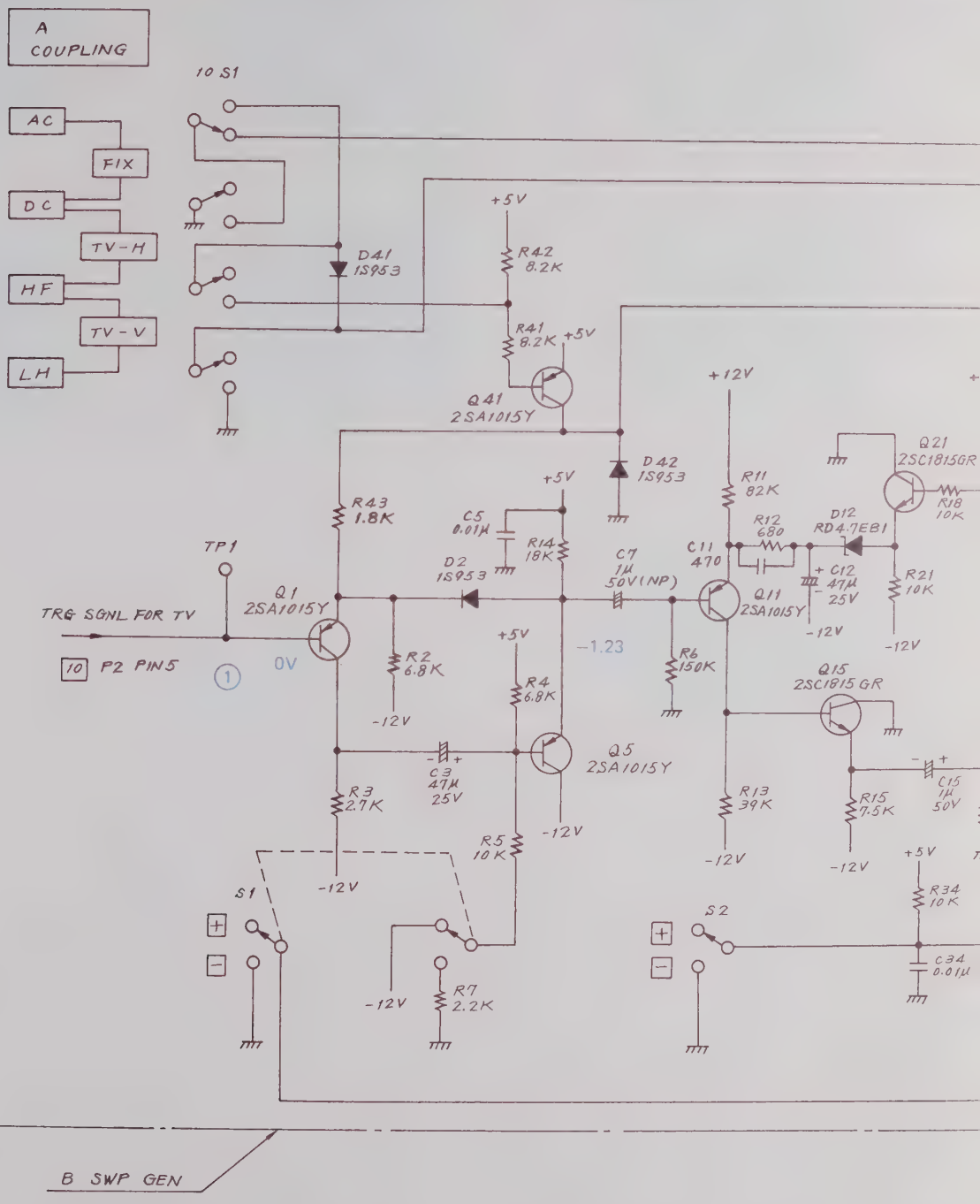


20μ S

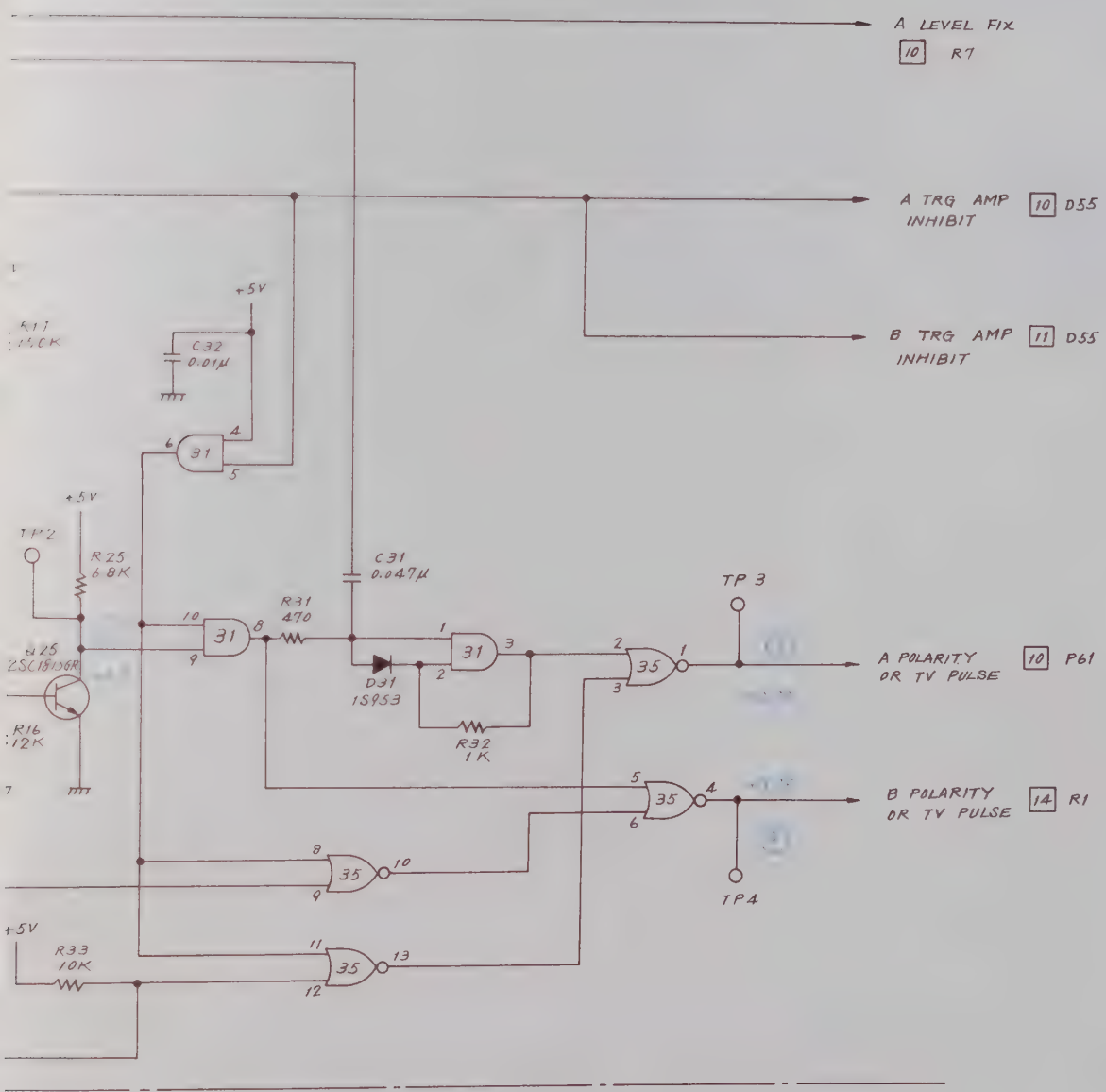
③ 4V ≈+2V



20μ S



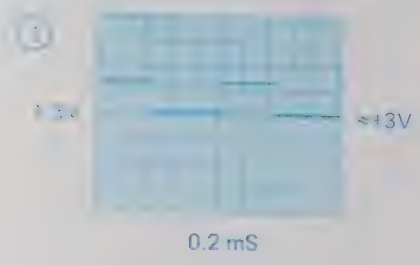
		+5V	GND
IC 31	SN 74LS08N	14	7
IC 35	SN 74LS02N	14	7

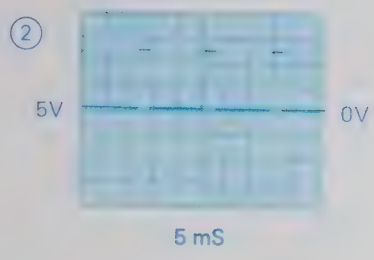


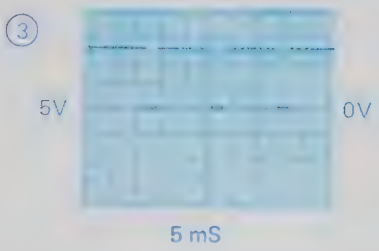
& WAVEFORM READING CONDITIONS
. .TV-H

SS-5711/SS-5711C/SS-5711D
TV SYNC SEPARATOR 12

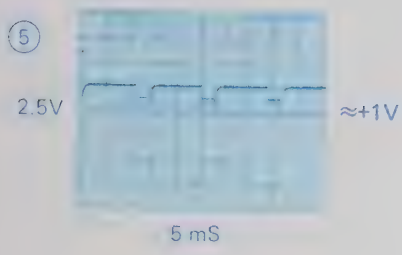
BBWSS34003102 4

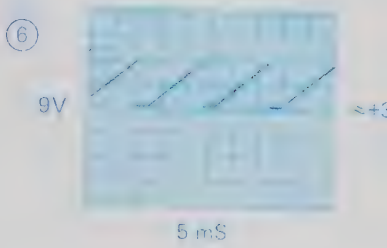

≈+3V
0.2 mS


5V
0V
5 mS

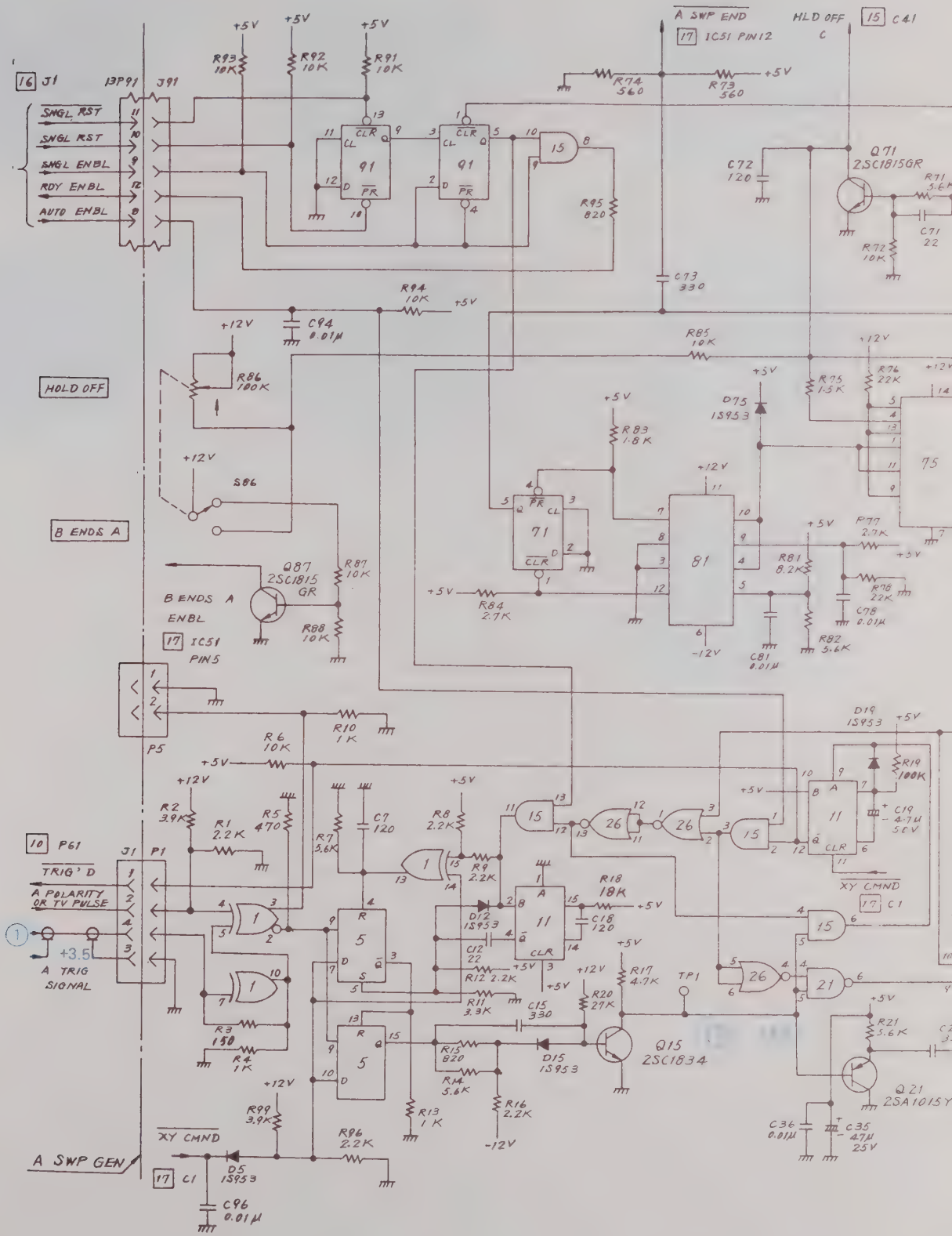

5V
0V
5 mS

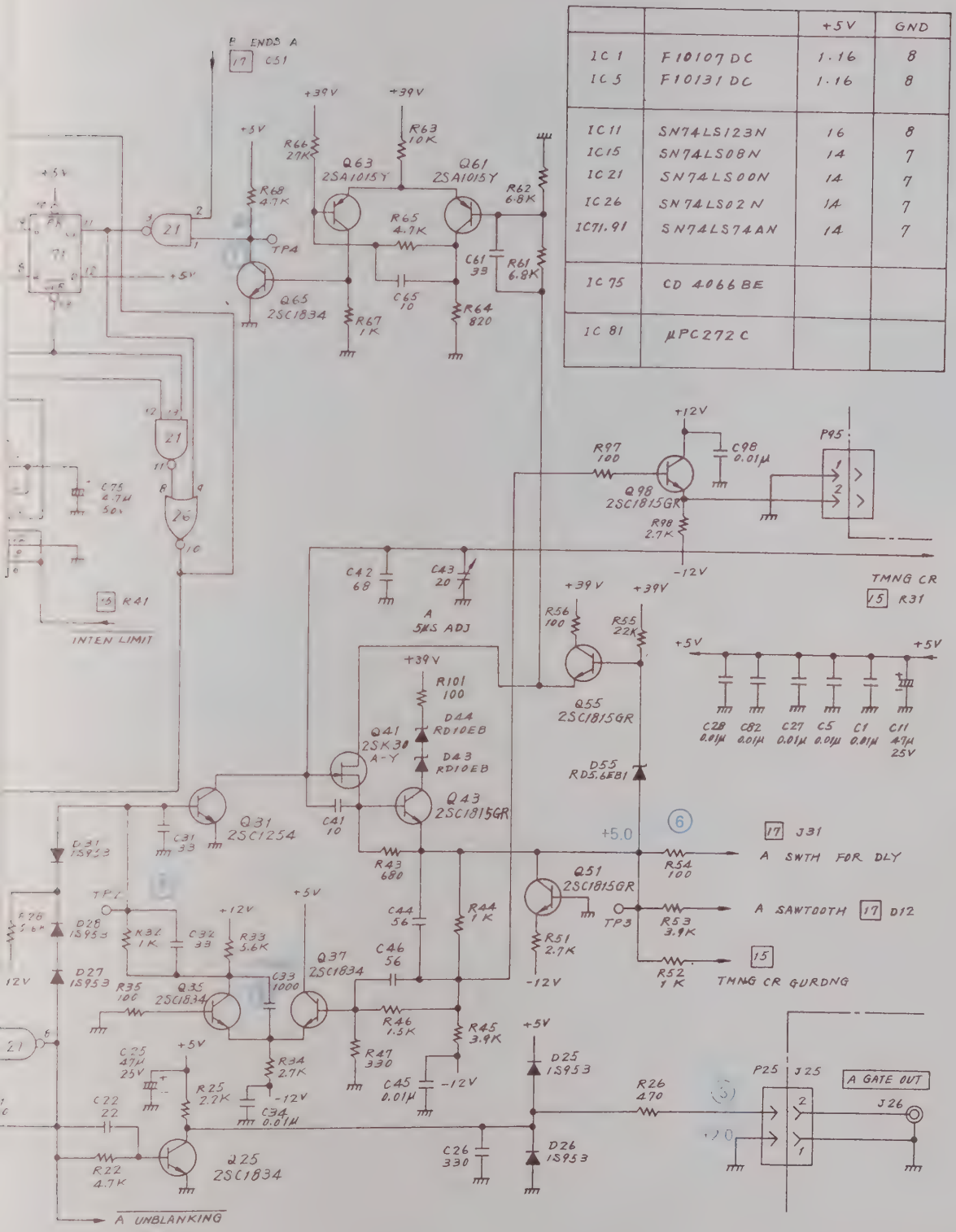
0V


2.5V
≈+1V
5 mS


9V
5 mS

0V


A SWP END
HLD OFF
16 J1
13P91
J91
SNGL RST
SNGL RST
SNGL ENBL
RDY ENBL
AUTO ENBL
+5V
R93 10K
R92 10K
R91 10K
R74 560
R73 560
C72 120
Q71 2SC1815GR
R71 5.6K
C71 22
R72 10K
R95 820
C73 330
R94 10K
C94 0.01μ
R85 10K
+12V
R86 100K
HOLD OFF
S86
B ENDS A
Q87 2SC1815 GR
R87 10K
R88 10K
B ENDS A ENBL
17 IC51 PIN5
R83 1.8K
D75 1S953
R75 1.5K
R76 22K
R77 2.7K
R81 8.2K
R78 22K
C78 0.01μ
R84 2.7K
R82 5.6K
C81 0.01μ
-12V
P5
R10 1K
R6 10K
D19 1S953
R19 100K
C19 4.7μ 25V
XY CMND
17 C1
10 P61
J1 P1
TRIG'D
A POLARITY OR TV PULSE
A TRIG SIGNAL
+3.5
R2 3.9K
R1 2.2K
R5 470
R7 5.6K
C7 120
R8 2.2K
R9 2.2K
D12 1S953
C12 22
R12 2.2K
R11 3.3K
R18 18K
C18 120
R17 4.7K
TP1
R20 27K
C15 330
R3 150
R4 1K
R13 1K
R14 5.6K
R15 820
D15 1S953
Q15 2SC1834
R16 2.2K
R21 5.6K
Q21 2SA1015Y
C36 0.01μ
C35 47μ 25V
R99 3.9K
R96 2.2K
A SWP GEN
17 C1
D5 1S953
C96 0.01μ



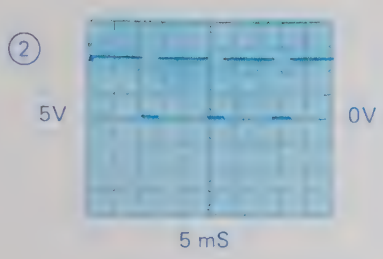
		+5V	GND
IC 1	F10107DC	1.16	8
IC 5	F10131DC	1.16	8
IC 11	SN74LS123N	16	8
IC 15	SN74LS08N	14	7
IC 21	SN74LS00N	14	7
IC 26	SN74LS02N	14	7
IC 71, 91	SN74LS74AN	14	7
IC 75	CD 4066BE		
IC 81	µPC272C		

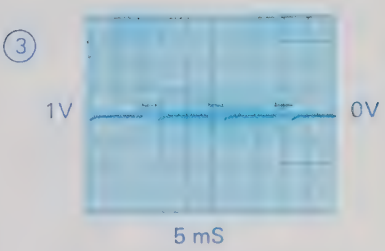
SS-5711C/SS-5711D

A SWEEP GENERATOR 13

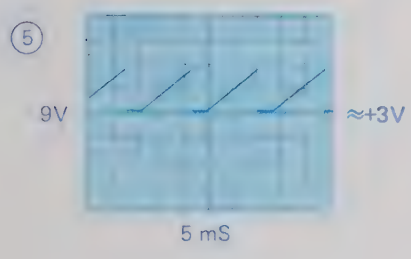
BBWSS20034105 1

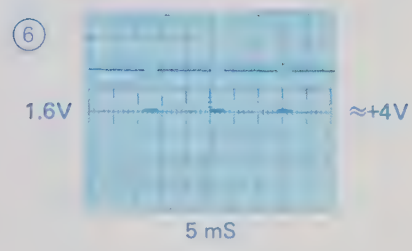
1
≈+3V
0.2 mS

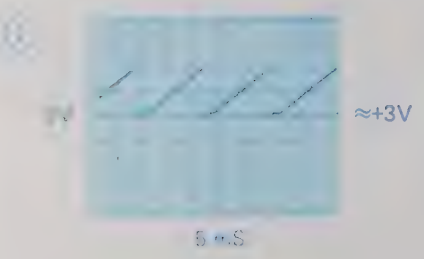

2
5V
0V
5 mS


3
1V
0V
5 mS

4
2.5V
≈+1V
5 mS

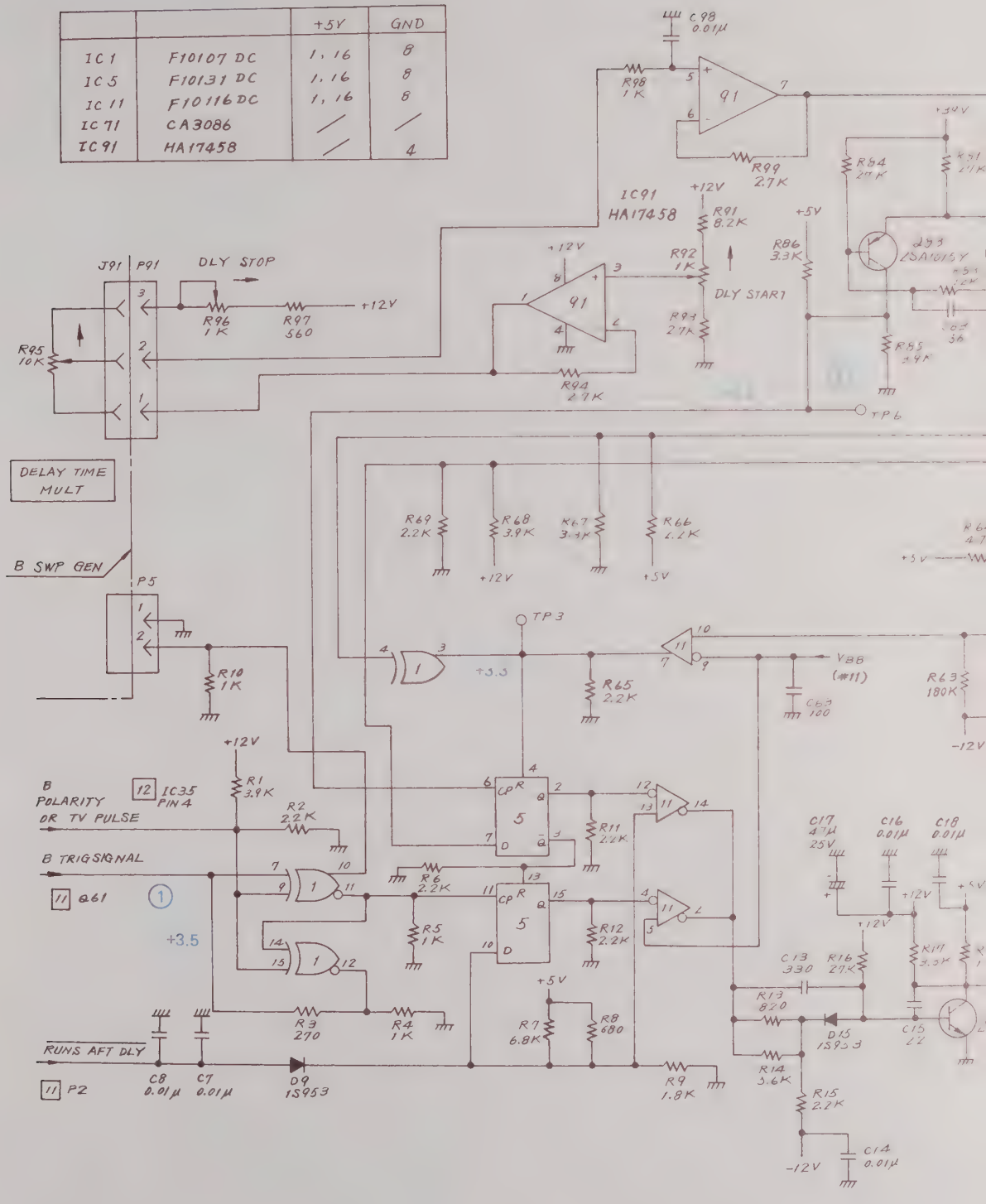

5
9V
≈+3V
5 mS


6
1.6V
≈+4V
5 mS

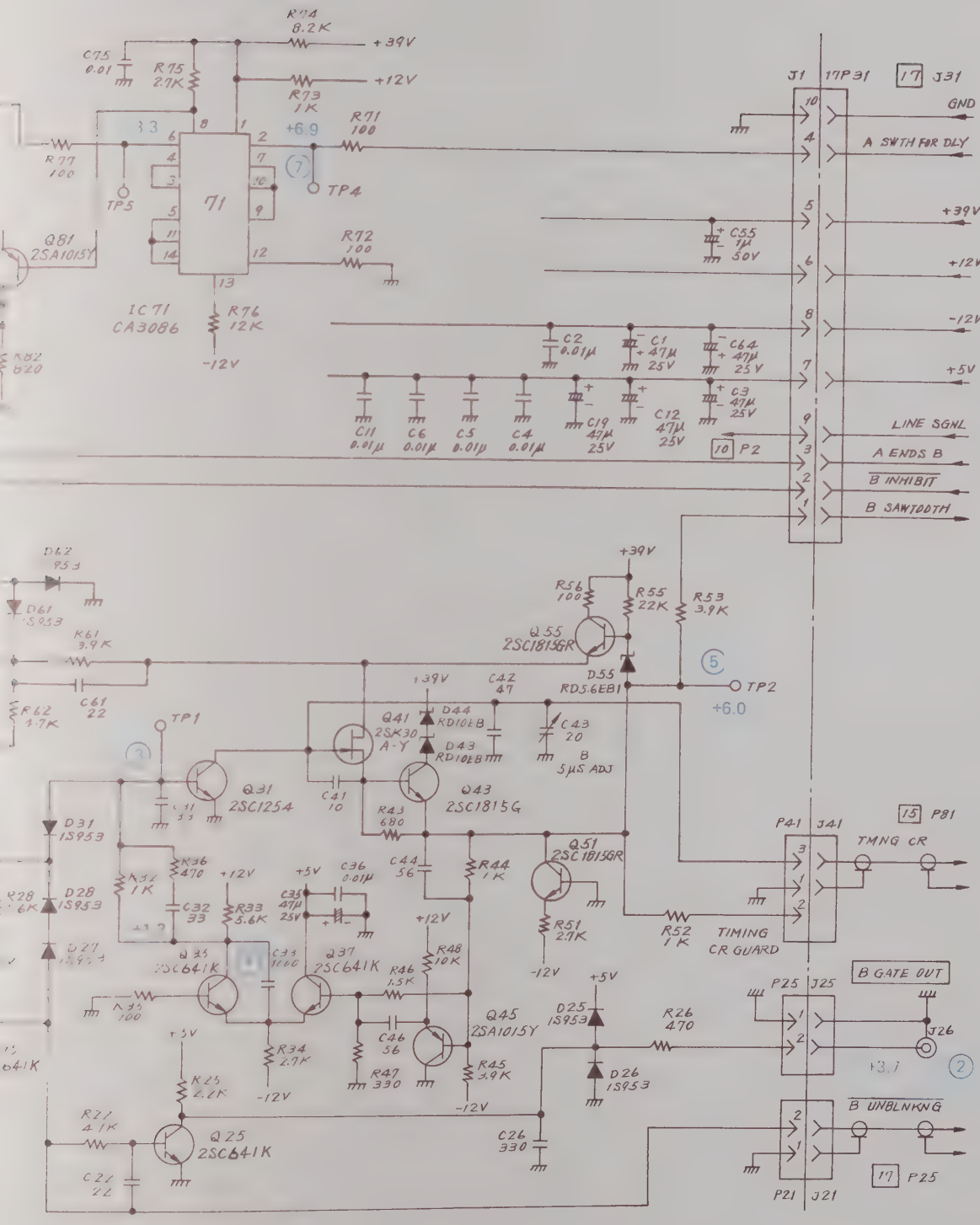

≈+3V
5 mS

WAVEFORMS

		+5V	GND
IC 1	F10107 DC	1, 16	8
IC 5	F10131 DC	1, 16	8
IC 11	F10116 DC	1, 16	8
IC 71	CA3086	/	/
IC 91	HA17458	/	4



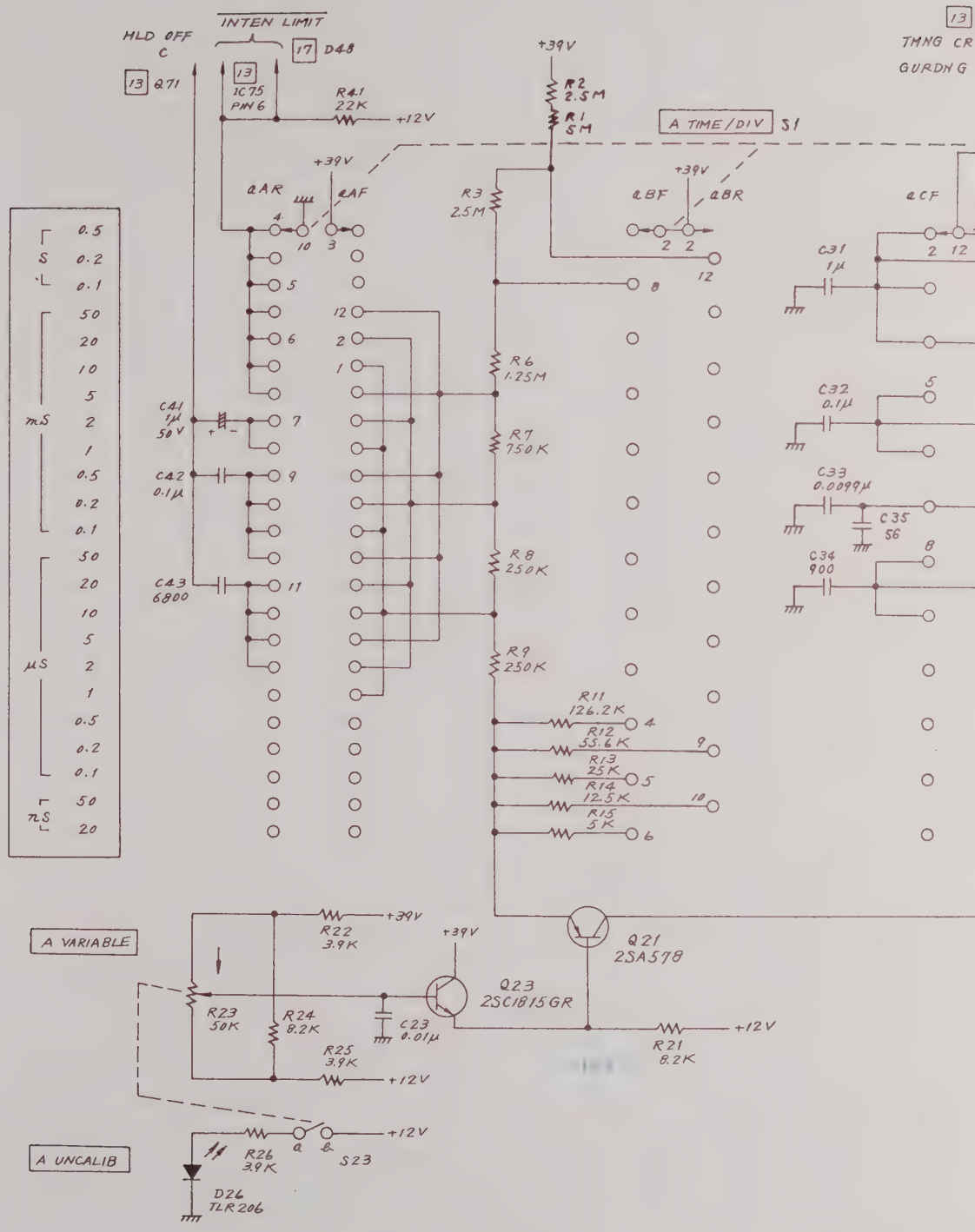
VOLTAGE & WAVEFORM READING CONDITIONS
HORIZ DISPLAY. . . . . .B(DLY'D)

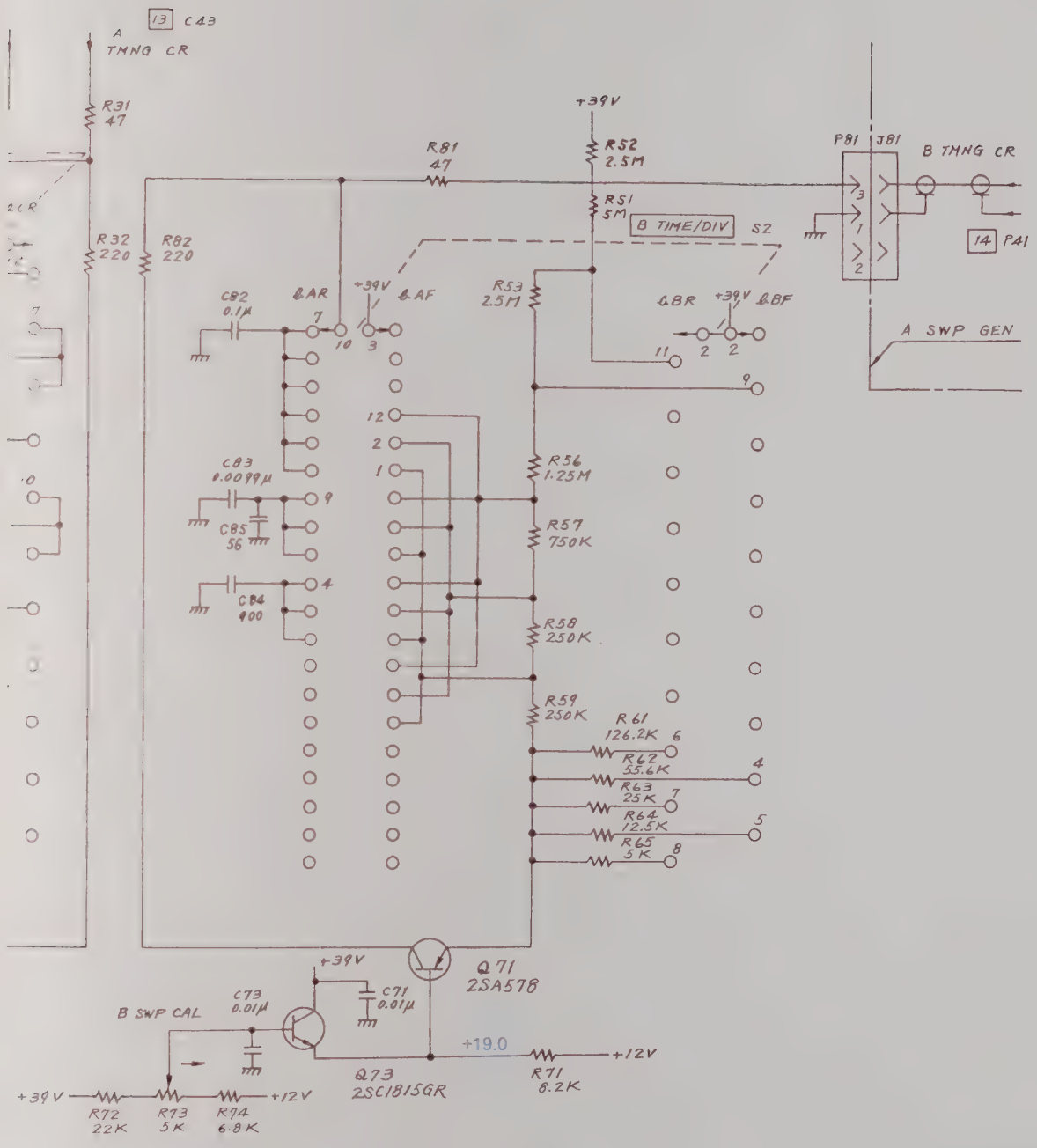


SS-5711/SS-5711C/SS-5711D
SS-578+

B SWEEP GENERATOR 14

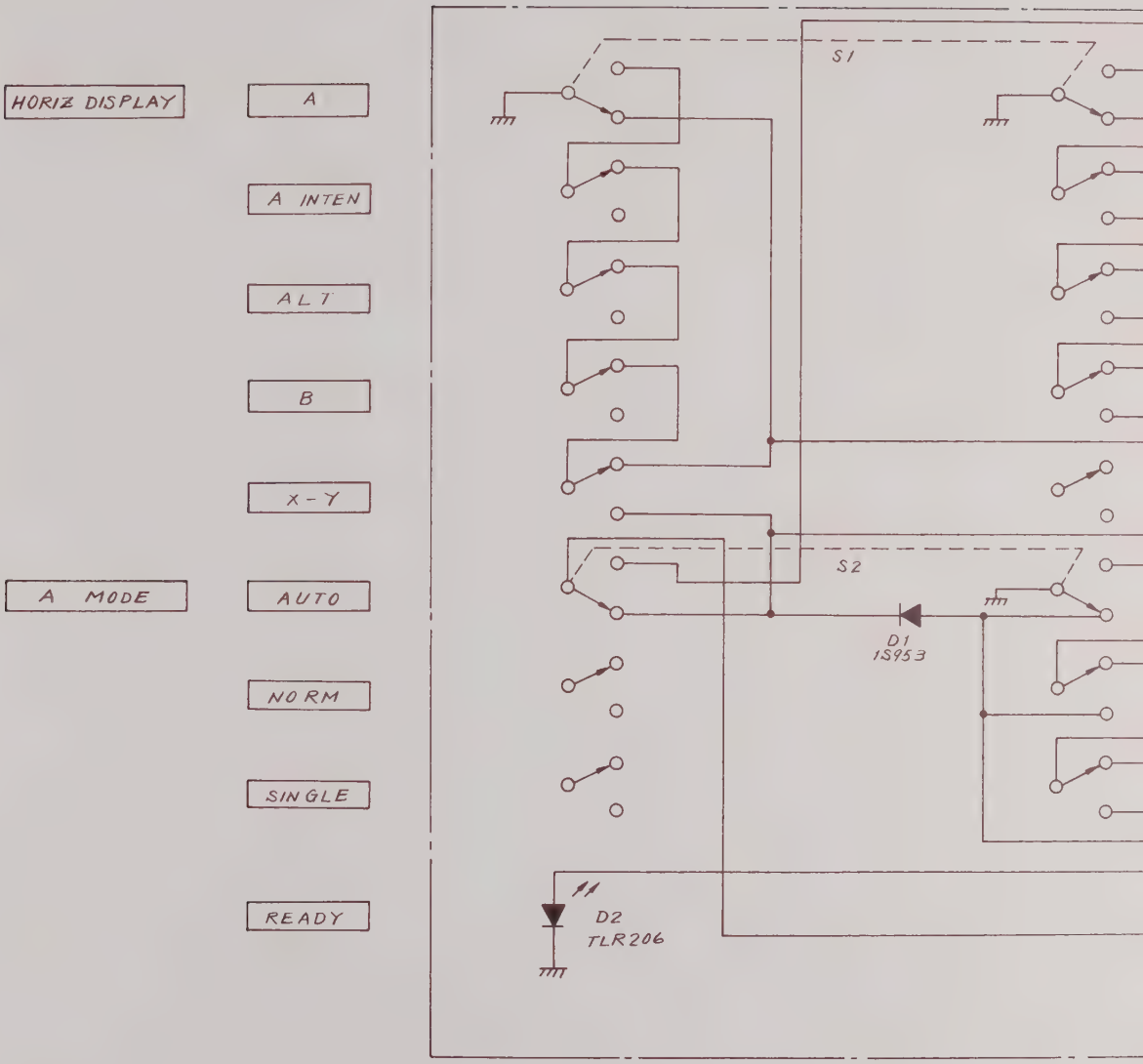
BBWSS20005102 6

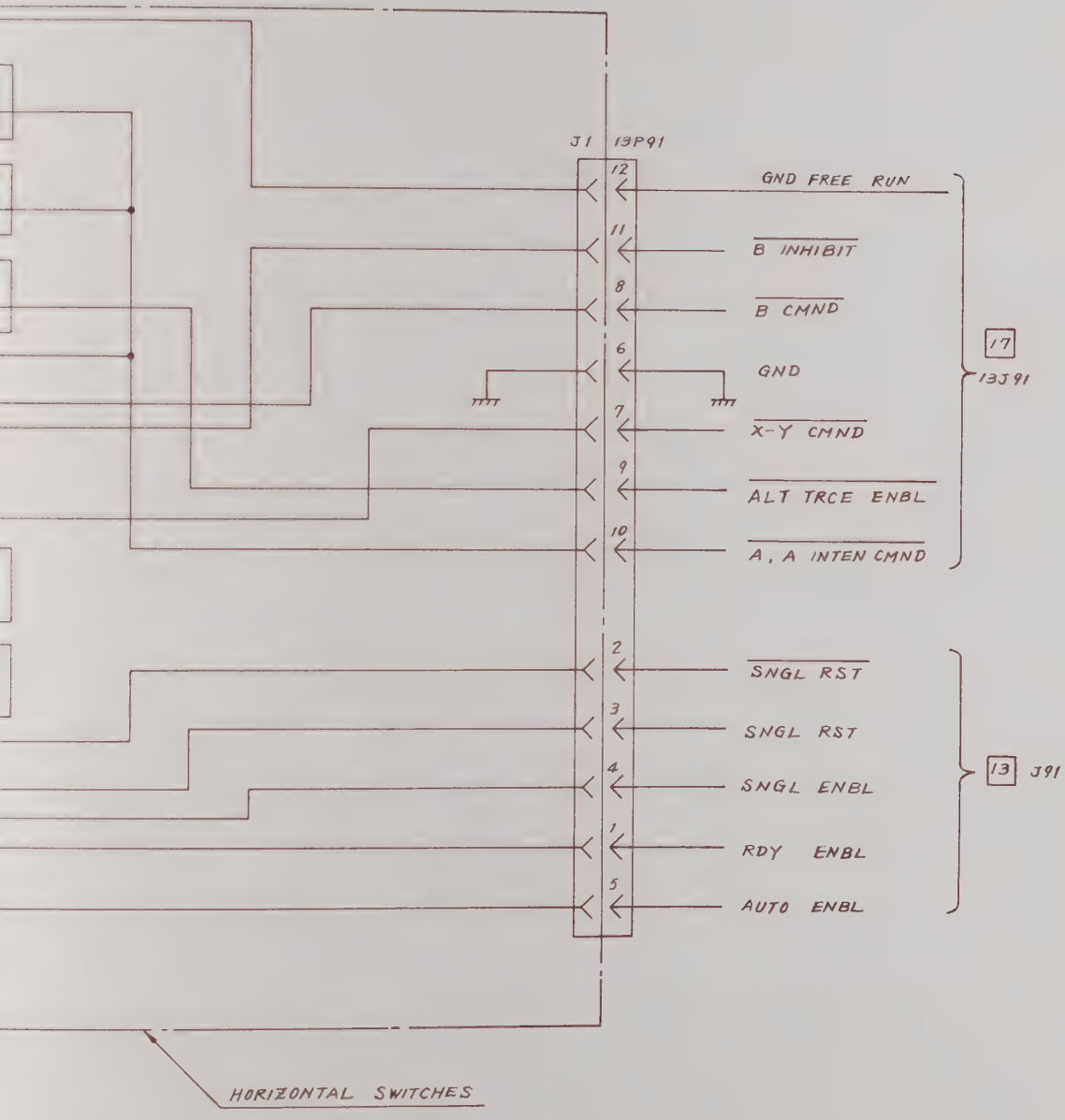

HLD OFF
C
13 Q71
INTEN LIMIT
13 IC75 PIN 6
17 D48
R41 22K
+12V
+39V
R2 2.5M
R1 5M
A TIME/DIV S1
QAR
QAF
QBF
QBR
QCF
R3 2.5M
0.5
0.2
0.1
50
20
10
5
2
1
0.5
0.2
0.1
50
20
10
5
2
1
0.5
0.2
0.1
50
20
S
mS
µS
nS
C41 1µ 50V
C42 0.1µ
C43 6800
R6 1.25M
R7 750K
R8 250K
R9 250K
C31 1µ
C32 0.1µ
C33 0.0099µ
C35 56
C34 900
R11 126.2K
R12 55.6K
R13 25K
R14 12.5K
R15 5K
A VARIABLE
R22 3.9K
R23 50K
R24 8.2K
R25 3.9K
C23 0.01µ
Q23 2SC1815GR
Q21 2SA578
R21 8.2K
A UNCALIB
R26 3.9K
S23
D26 TLR206
TMNG CR
GURDN G

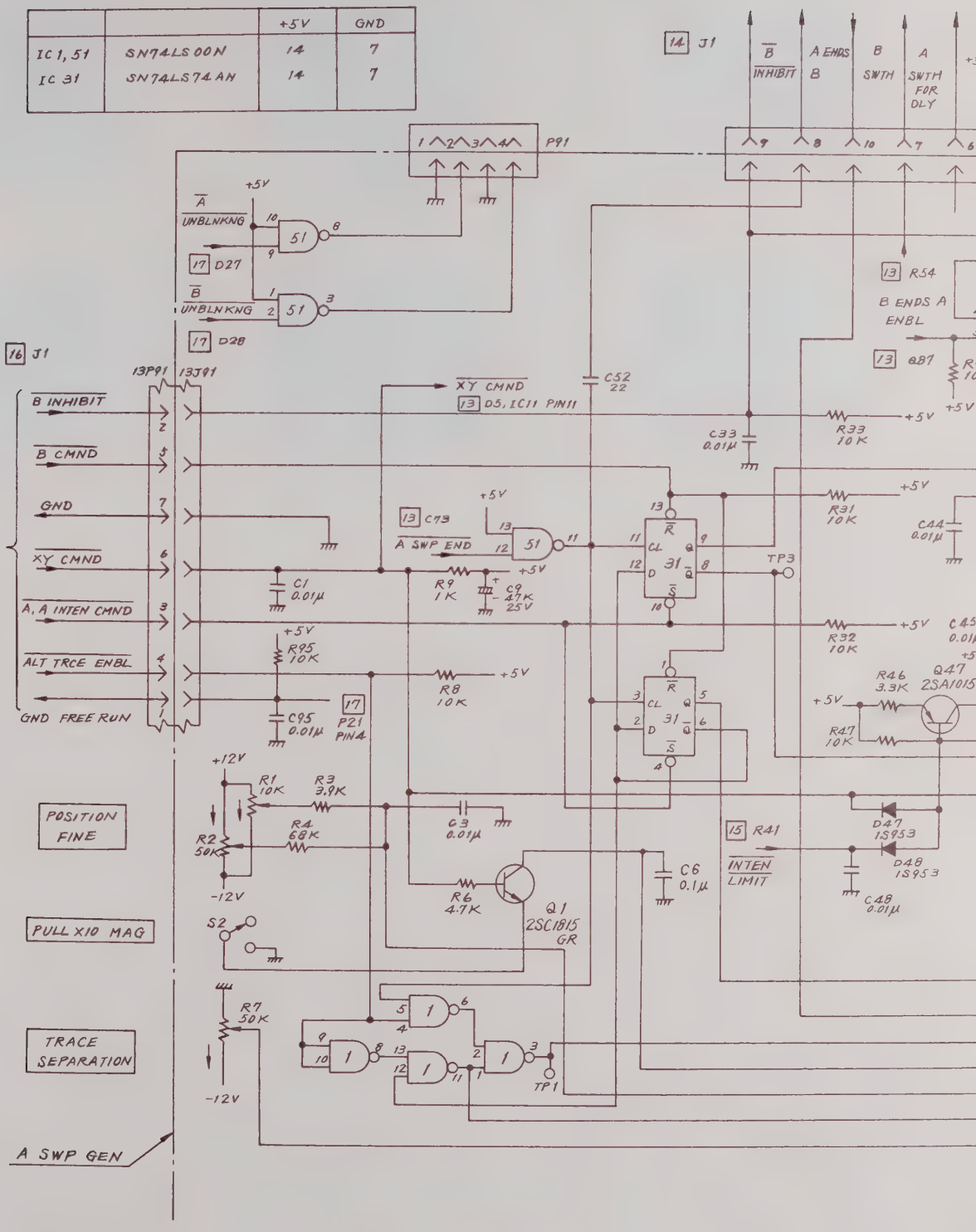


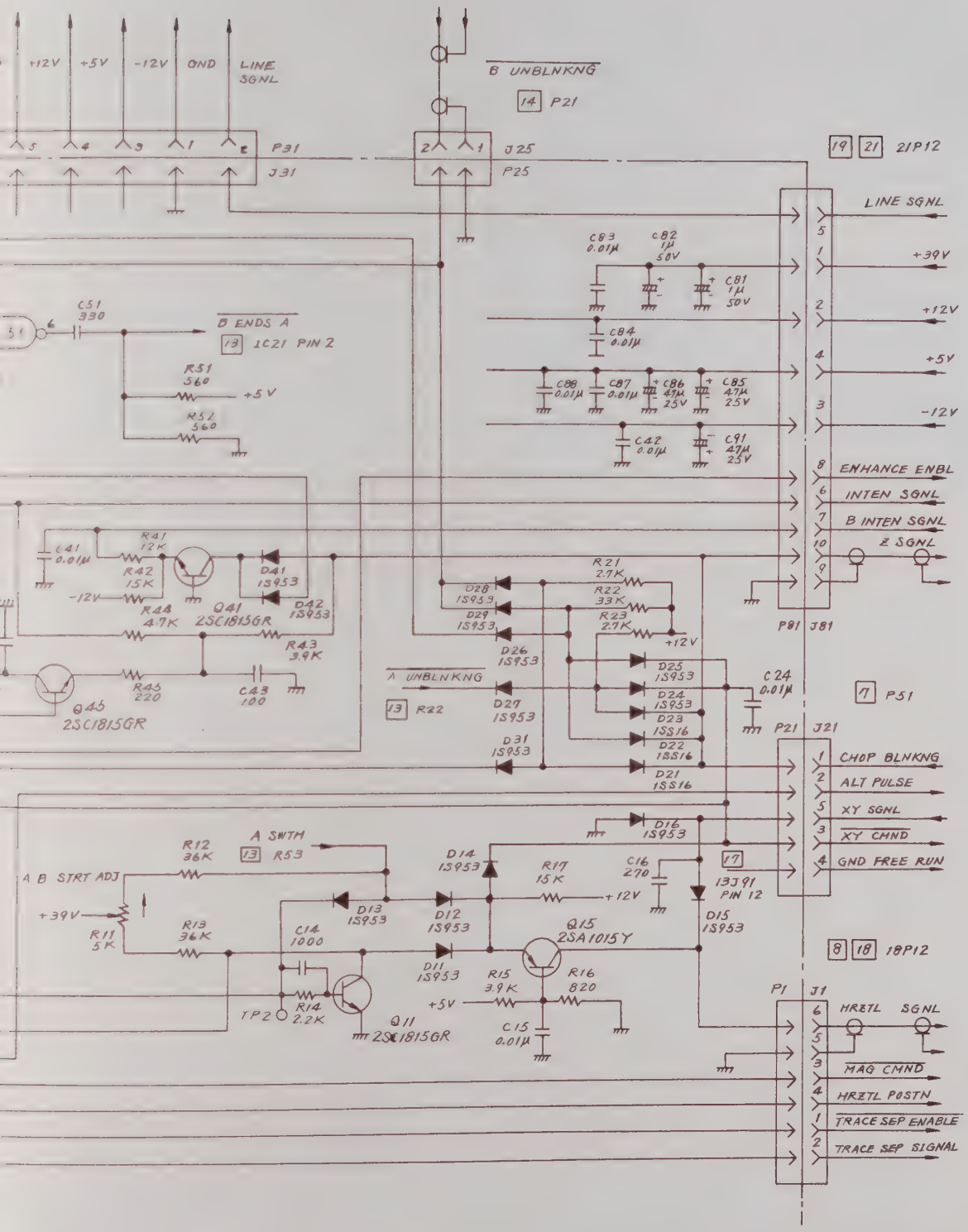
SS-5711/SS-5711C/SS-5711D
SS-5784
TIMING SWITCHES 15

BBWSS20006102 6


HORIZ DISPLAY
A
A INTEN
ALT
B
X-Y
A MODE
AUTO
NORM
SINGLE
READY
S1
S2
D1
1S953
D2
TLR206


J1 13P91
12
GND FREE RUN
11
B INHIBIT
8
B CMND
6
GND
7
X-Y CMND
9
ALT TRCE ENBL
10
A, A INTEN CMND
17
13J91
2
SNGL RST
3
SNGL RST
4
SNGL ENBL
1
RDY ENBL
5
AUTO ENBL
13 J91
HORIZONTAL SWITCHES

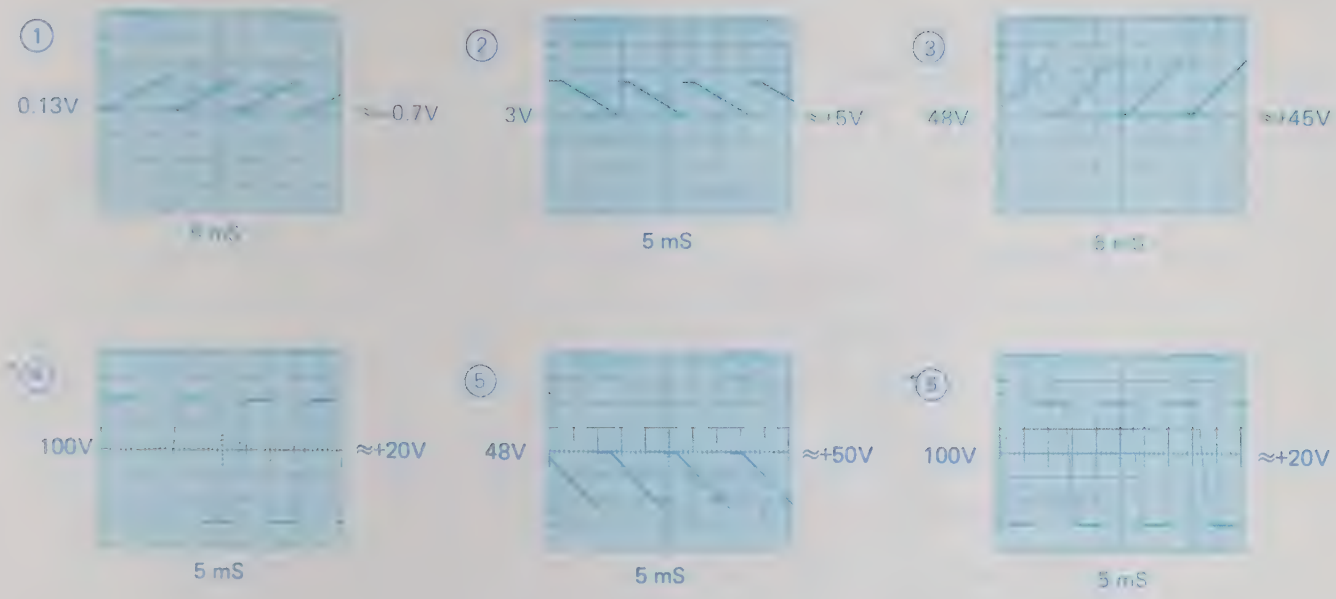

IC 1, 51 SN74LS00N +5V 14 GND 7
IC 31 SN74LS74AN +5V 14 GND 7
14 J1
B INHIBIT
A ENDS B
B SWTH
A SWTH FOR DLY
P91
A UNBLNKNG
B UNBLNKNG
17 D27
17 D28
16 J1
13P91
13J91
B INHIBIT
B CMND
GND
XY CMND
A, A INTEN CMND
ALT TRCE ENBL
GND FREE RUN
XY CMND
13 D5, IC11 PIN11
13 C73
A SWP END
13 R54
B ENDS A ENBL
13 Q87
C52 22
C33 0.01µ
R33 10K
R31 10K
C44 0.01µ
R32 10K
C45 0.01µ
C1 0.01µ
R9 1K
C9 47K 25V
TP3
R95 10K
R8 10K
C95 0.01µ
17 P21 PIN4
R46 3.3K
Q47 2SA1015
R47 10K
+12V
R1 10K
R3 3.9K
R2 50K
R4 68K
-12V
POSITION FINE
C3 0.01µ
R6 4.7K
Q1 2SC1815 GR
C6 0.1µ
15 R41
INTEN LIMIT
D47 1S953
D48 1S953
C48 0.01µ
S2
PULL X10 MAG
R7 50K
TRACE SEPARATION
TP1
A SWP GEN

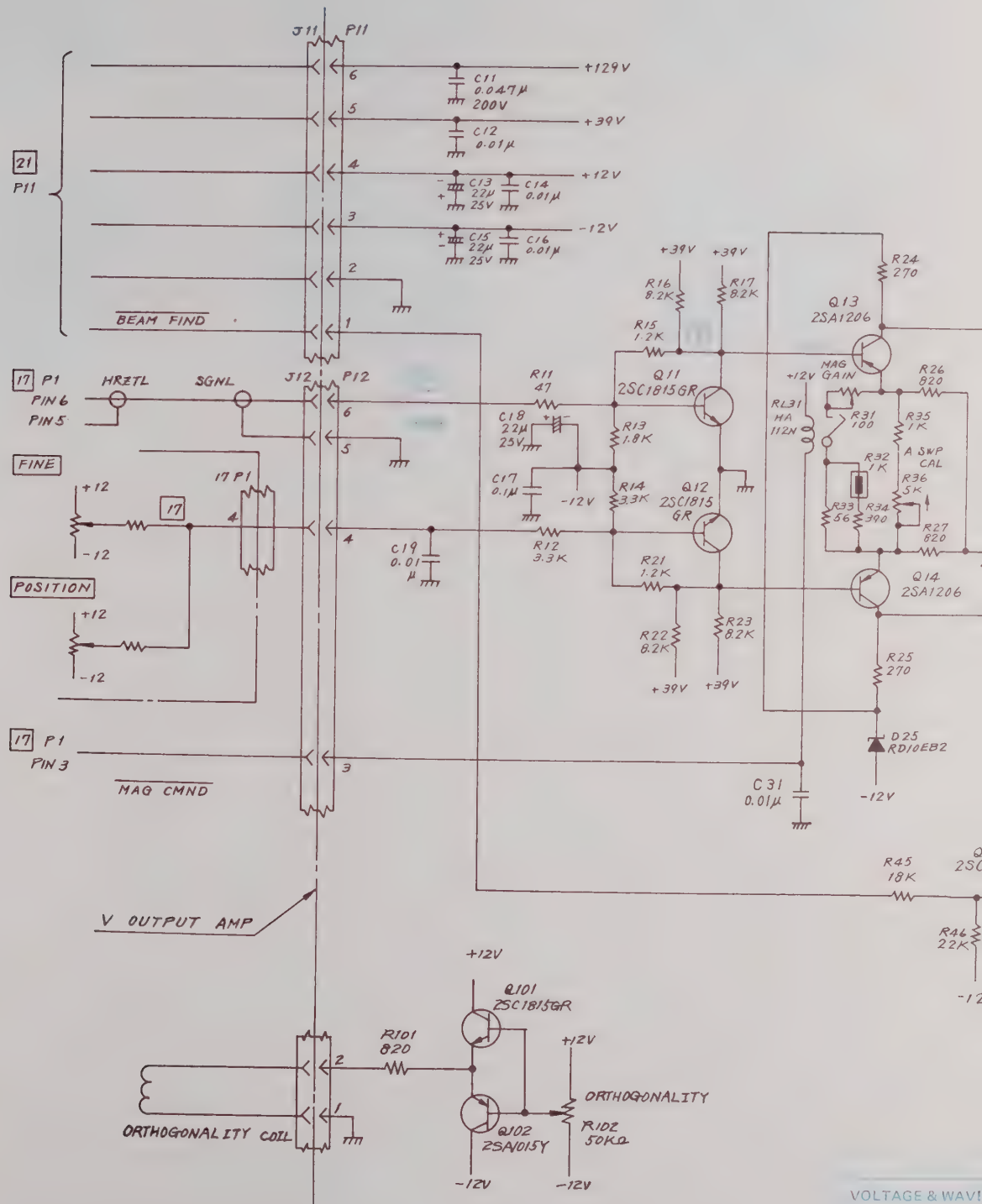


SS-5711/SS-5711C/SS-5711D

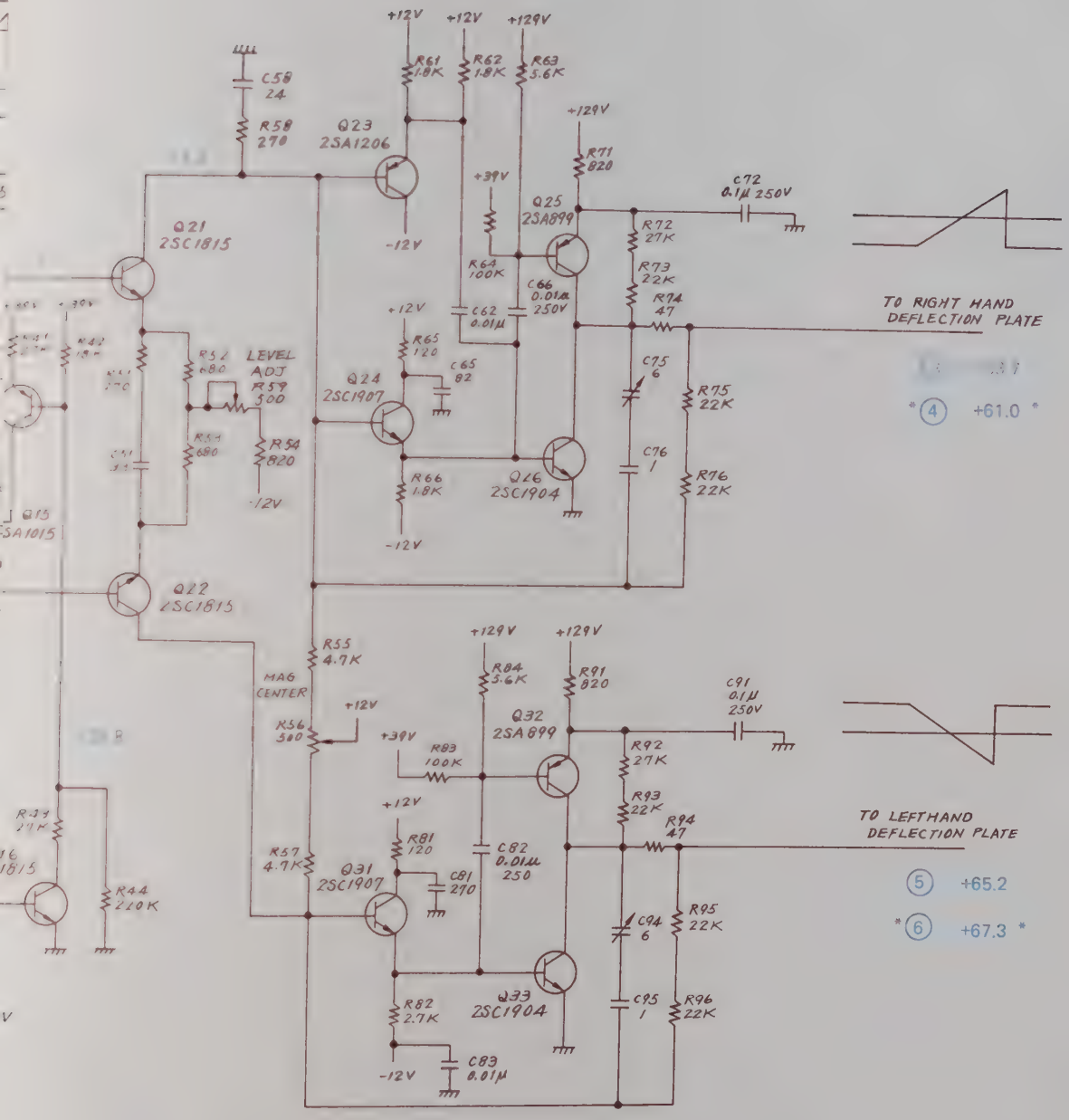
HORIZONTAL CONTROL 17

BBWSS10003102 4


①
0.13V
≈−0.7V
5 mS
②
3V
≈+5V
5 mS
③
48V
≈+45V
5 mS
④
100V
≈+20V
5 mS
⑤
48V
≈+50V
5 mS
⑥
100V
≈+20V
5 mS



VOLTAGE & WAV
* FINE (PULL X 10

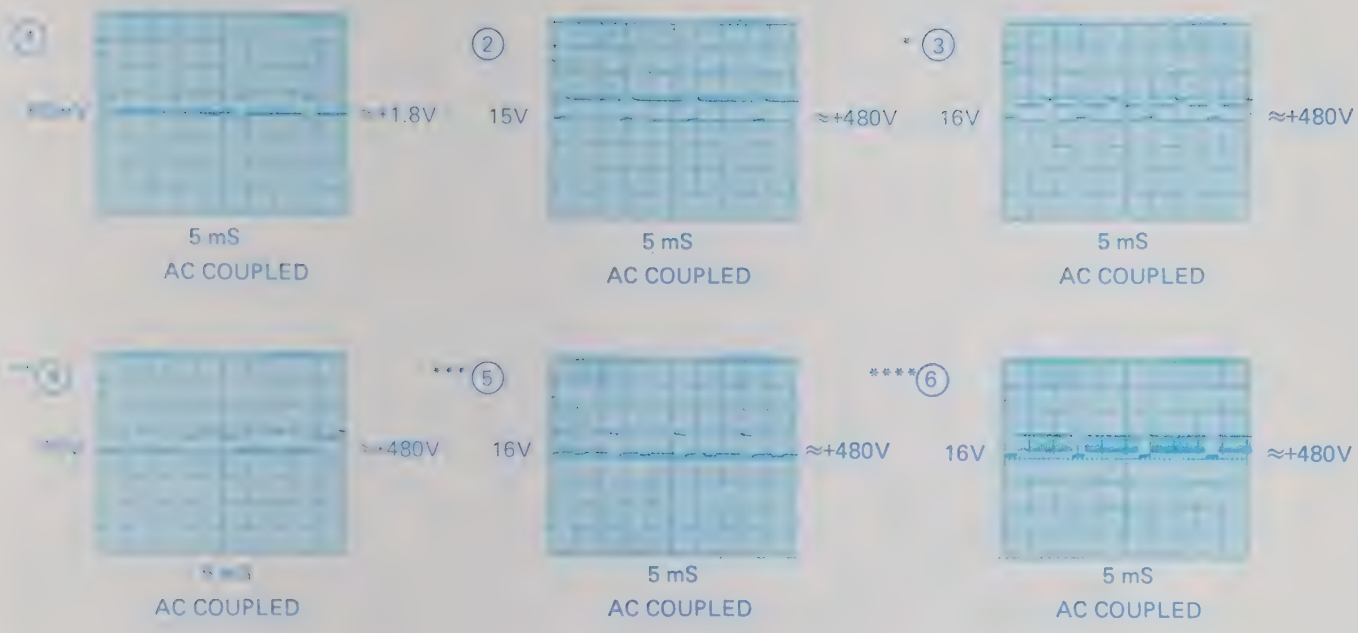


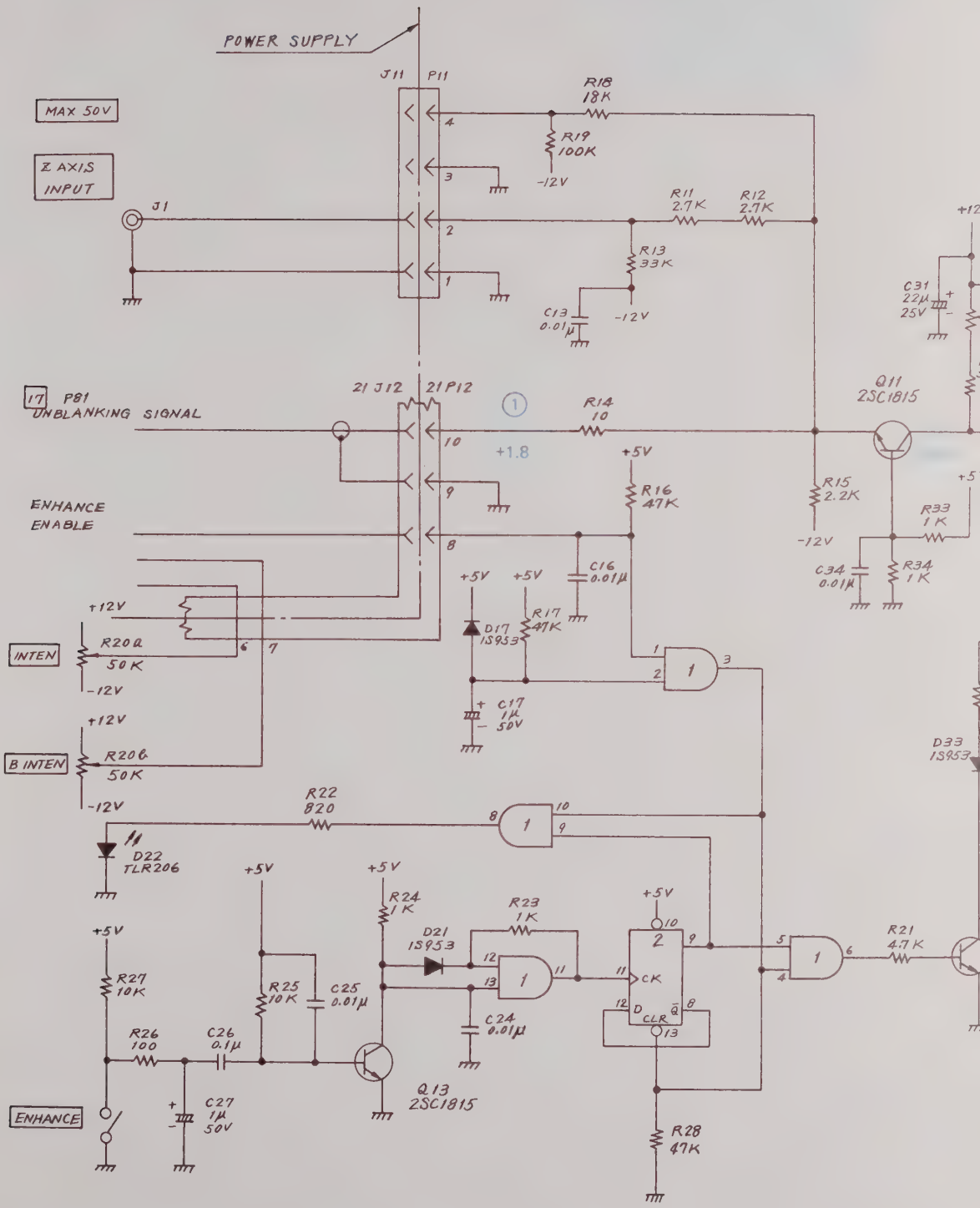
SS-5711 / SS-5711C / SS-5711D

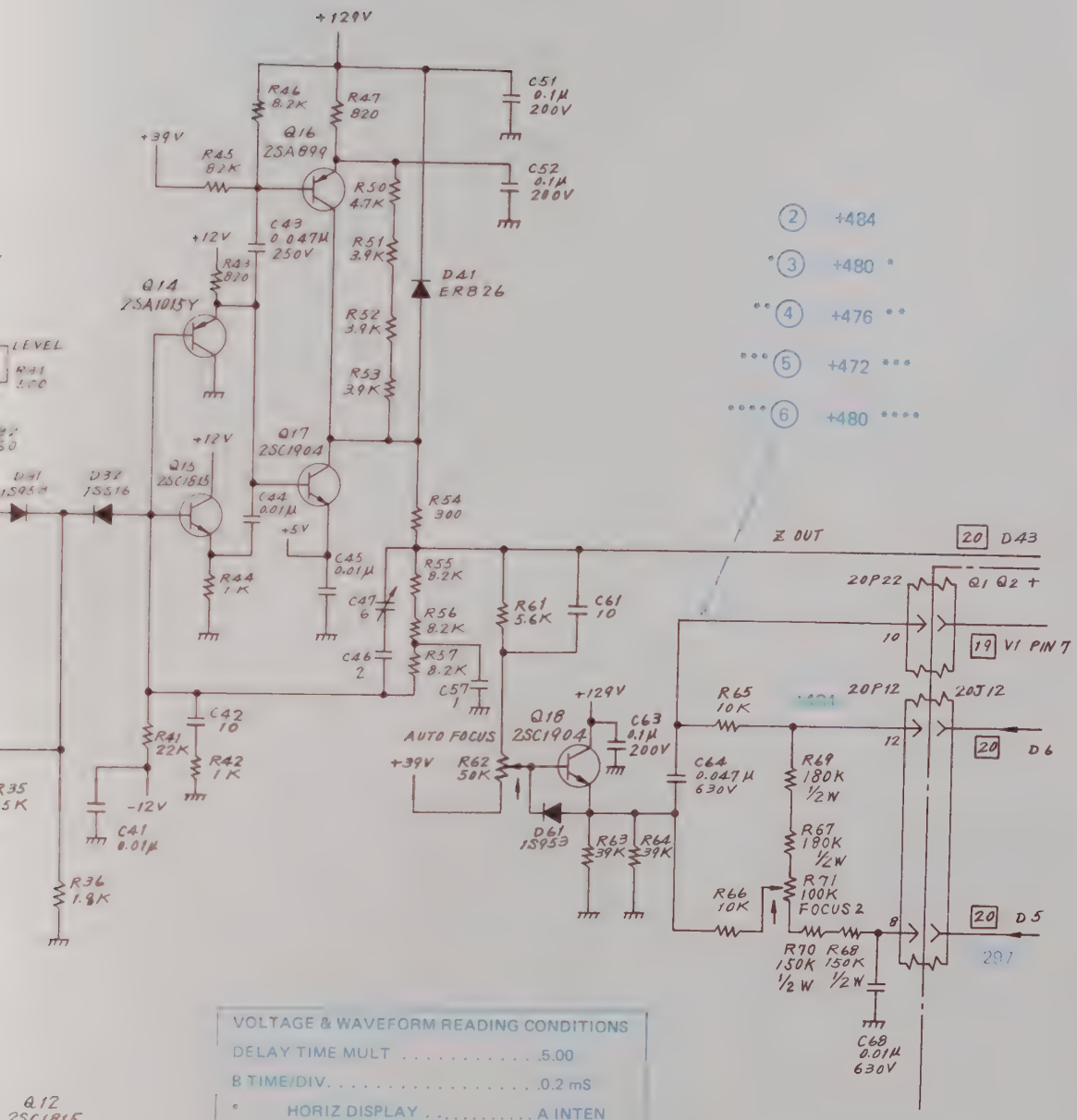
HORIZONTAL AMPLIFIER 18

BBWSS24016102 4

RM READING CONDITIONS
PULL


2
15V
≈+480V
5 mS
AC COUPLED
3
16V
≈+480V
5 mS
AC COUPLED
5
16V
≈+480V
5 mS
AC COUPLED
6
16V
≈+480V
5 mS
AC COUPLED


POWER SUPPLY
J11
P11
MAX 50V
Z AXIS INPUT
J1
R18 18K
R19 100K
-12V
R11 2.7K
R12 2.7K
R13 33K
C13 0.01μ
-12V
+12
C31 22μ 25V
Q11 2SC1815
17 P81 UNBLANKING SIGNAL
21 J12
21 P12
R14 10
+1.8
+5V
R16 47K
R15 2.2K
-12V
+5
R33 1K
C34 0.01μ
R34 1K
ENHANCE ENABLE
C16 0.01μ
+5V
+5V
D17 1S953
R17 47K
C17 1μ 50V
+12V
INTEN
R20a 50K
-12V
+12V
B INTEN
R20b 50K
-12V
D33 1S953
R22 820
D22 TLR206
+5V
+5V
R24 1K
R23 1K
D21 1S953
+5V
R21 4.7K
+5V
R27 10K
R25 10K
C25 0.01μ
C24 0.01μ
R26 100
C26 0.1μ
C27 1μ 50V
Q13 2SC1815
ENHANCE
R28 47K



VOLTAGE & WAVEFORM READING CONDITIONS

DELAY TIME MULT 5.00

B TIME/DIV. . . . . .0.2 mS

* HORIZ DISPLAY . . . . . A INTEN

** HORIZ DISPLAY . . . . . ALT

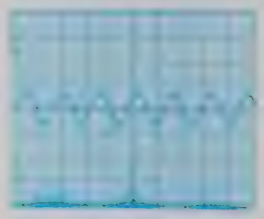
*** HORIZ DISPLAY . . . . . B (DLY'D)

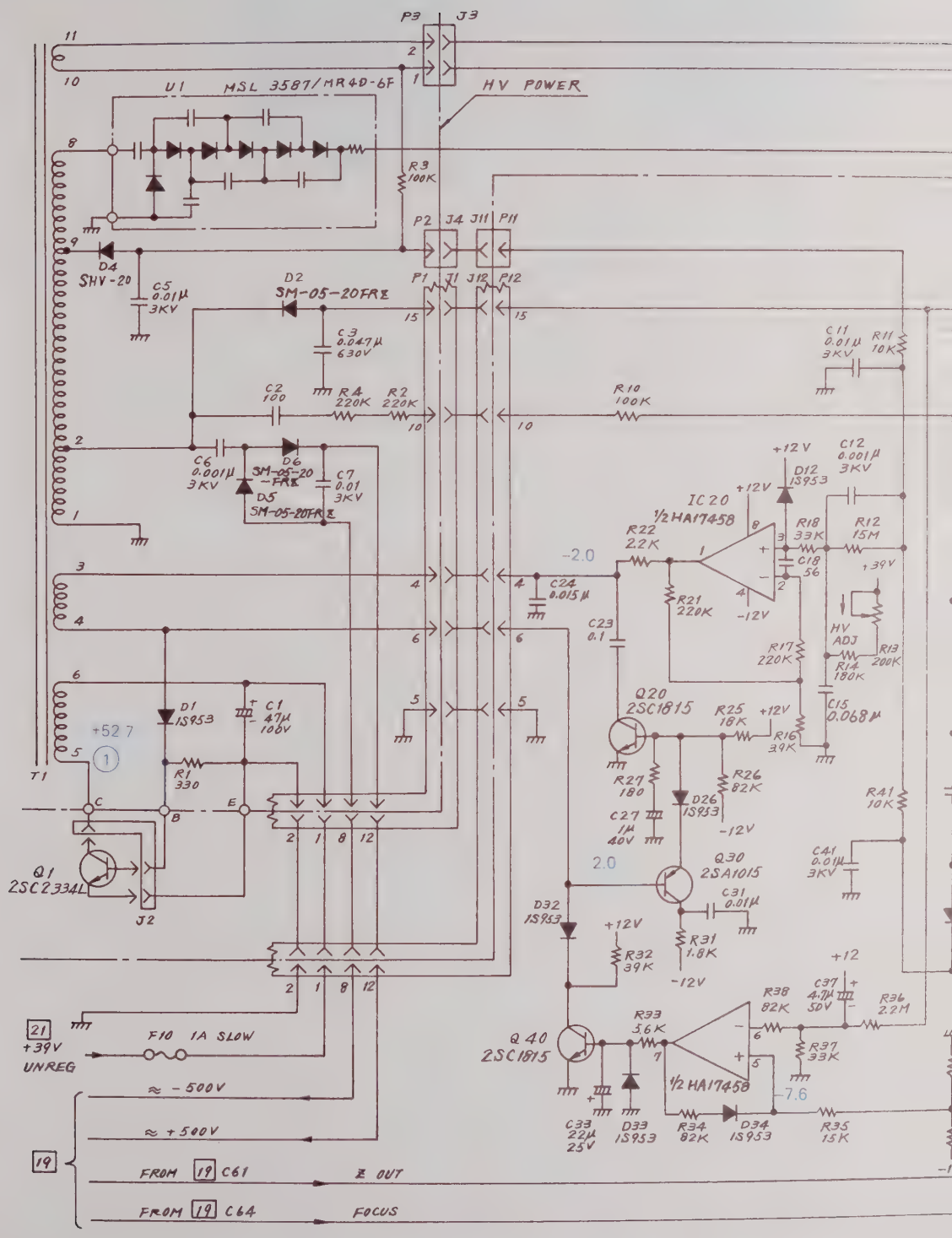
		GND	+5V
IC 1	74LS 08	7	14
IC 2	74LS74	7	14

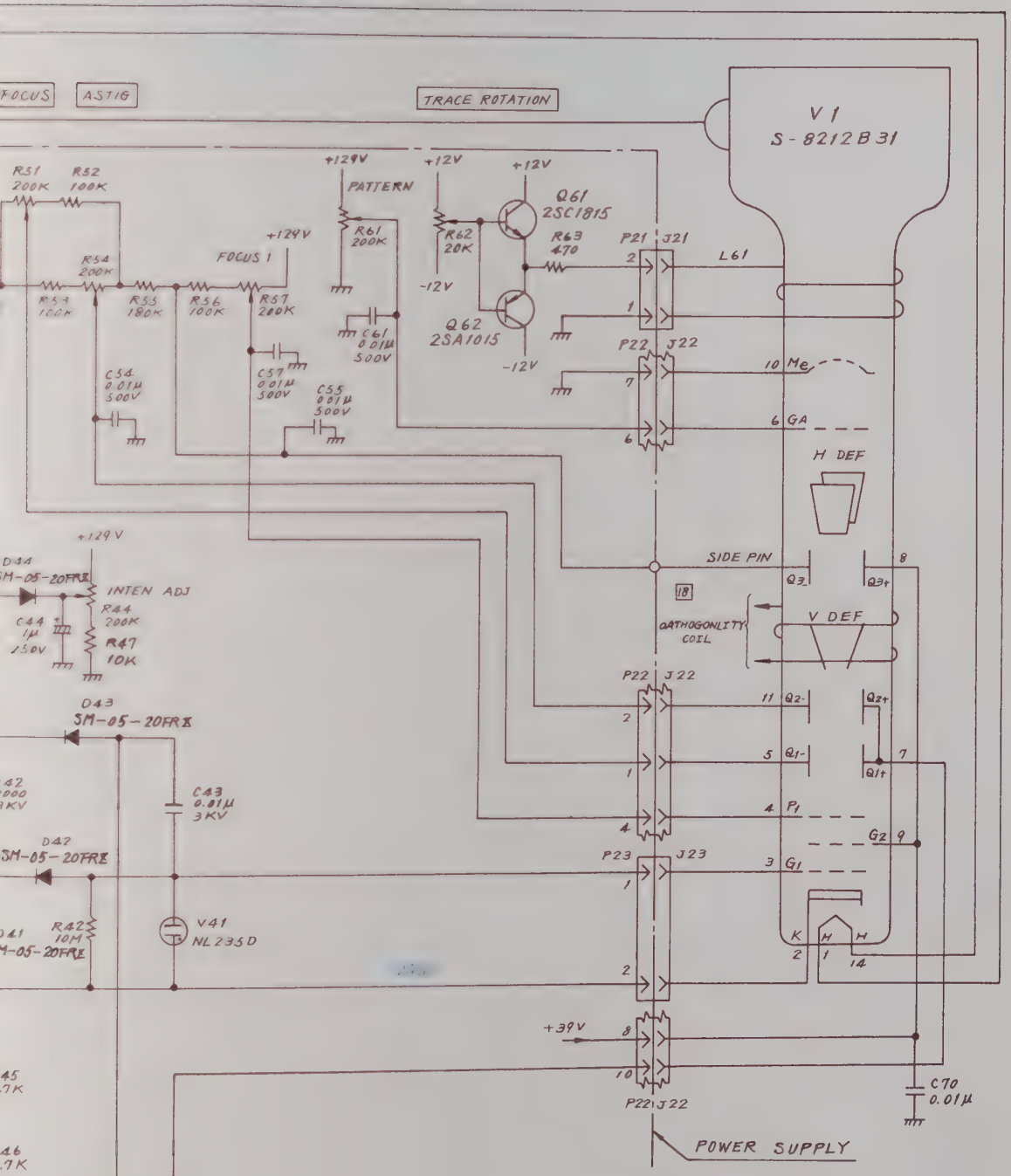
SS-5711/SS-5711C/SS-5711D
SS-5784

Z AXIS CIRCUIT 19

BBWSS24008102 6


≈+50V


P3 J3
HV POWER
U1 MSL 3587/MR40-6F
R3 100K
P2 J4 J11 P11
P1 J1 J12 P12
D4 SHV-20
C5 0.01μ 3KV
D2 SM-05-20FRE
C3 0.047μ 630V
C2 100
R4 220K
R2 220K
R10 100K
C6 0.001μ 3KV
D6 SM-05-20 -FRE
D5 SM-05-20FRE
C7 0.01 3KV
C11 0.01μ 3KV
R11 10K
C12 0.001μ 3KV
D12 1S953
+12V
IC20 1/2 HA17458
R18 33K
R12 15M
R22 2.2K
C18 56
R21 220K
-12V
+39V
HV ADJ
R14 180K
R13 200K
R17 220K
C15 0.068μ
C24 0.015μ
C23 0.1
Q20 2SC1815
R25 18K
R16 39K
R27 180
R26 82K
D26 1S953
C27 1μ 40V
R41 10K
C41 0.01μ 3KV
Q30 2SA1015
C31 0.01μ
D32 1S953
R31 1.8K
R32 39K
R38 82K
C37 4.7μ 50V
R36 2.2M
R33 3.6K
R37 33K
Q40 2SC1815
1/2 HA17458
C33 22μ 25V
D33 1S953
R34 82K
D34 1S953
R35 15K
D1 1S953
C1 47μ 100V
R1 330
+52 7
T1
Q1 2SC2334L
J2
F10 1A SLOW
21 +39V UNREG
≈ -500V
≈ +500V
19
FROM 19 C61
Z OUT
FROM 19 C64
FOCUS
-2.0
2.0
-7.6

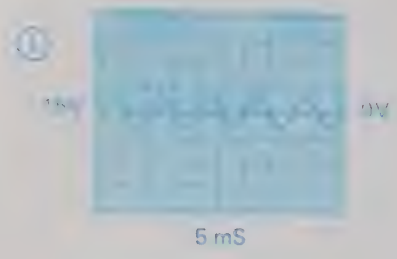


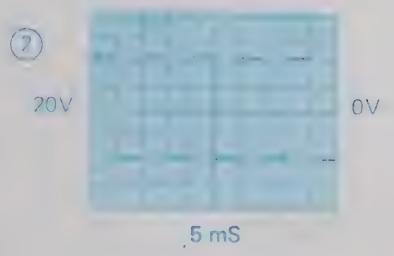
SS-5711/SS-5711C/SS-5711D
SS-5784

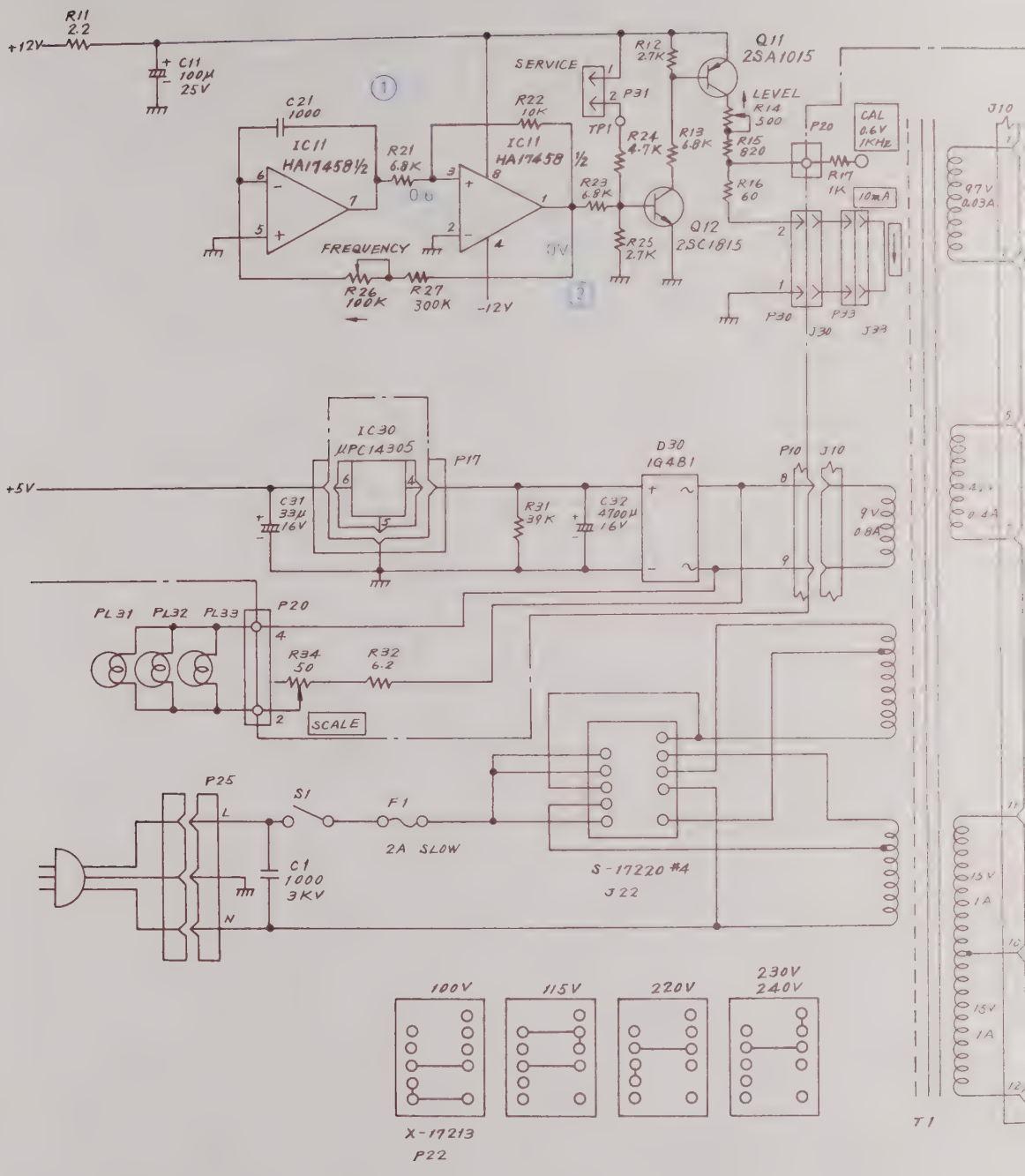
CRT CIRCUIT

20

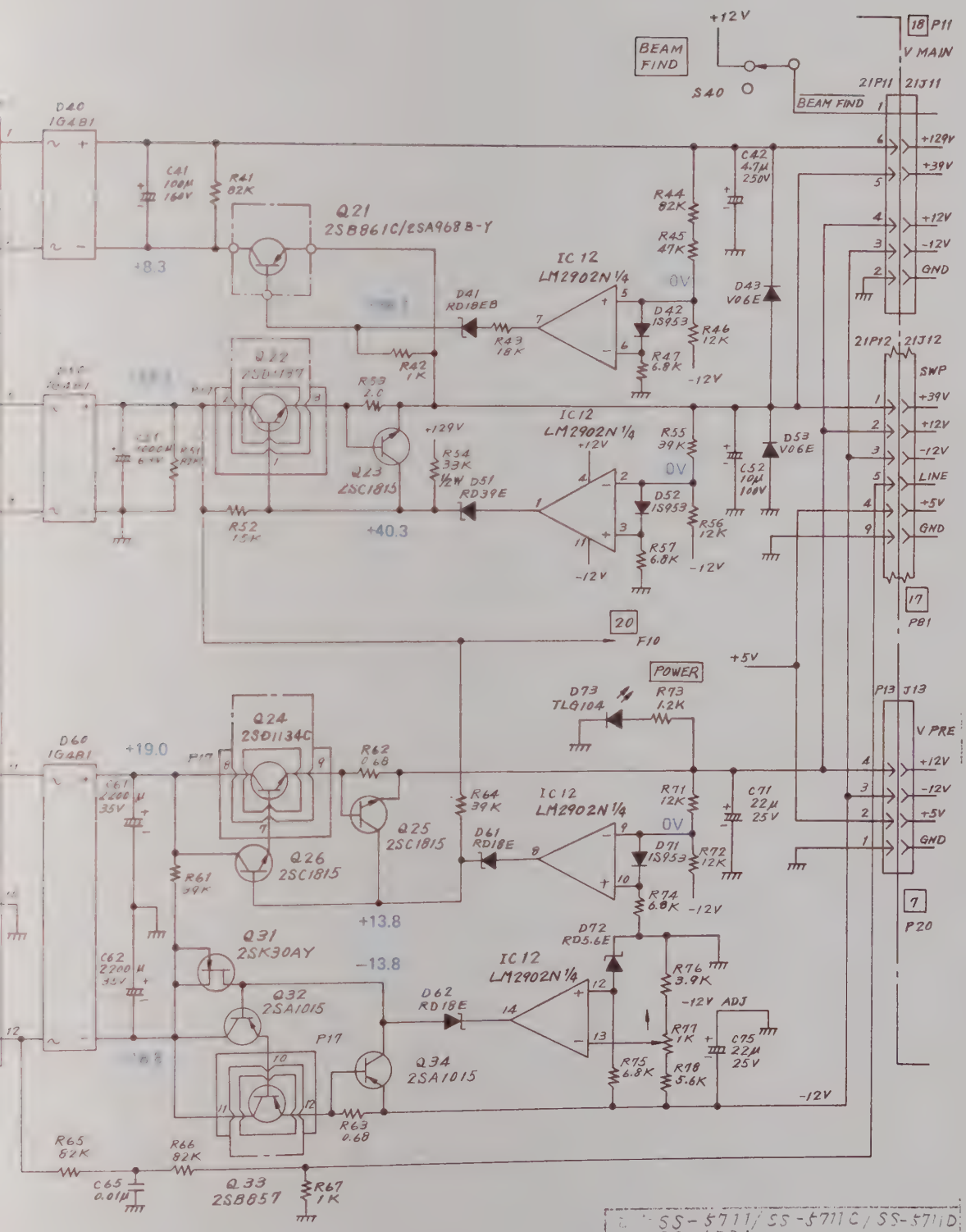
BBWSS08002102 7


①
0V
5 mS


②
20V
0V
5 mS



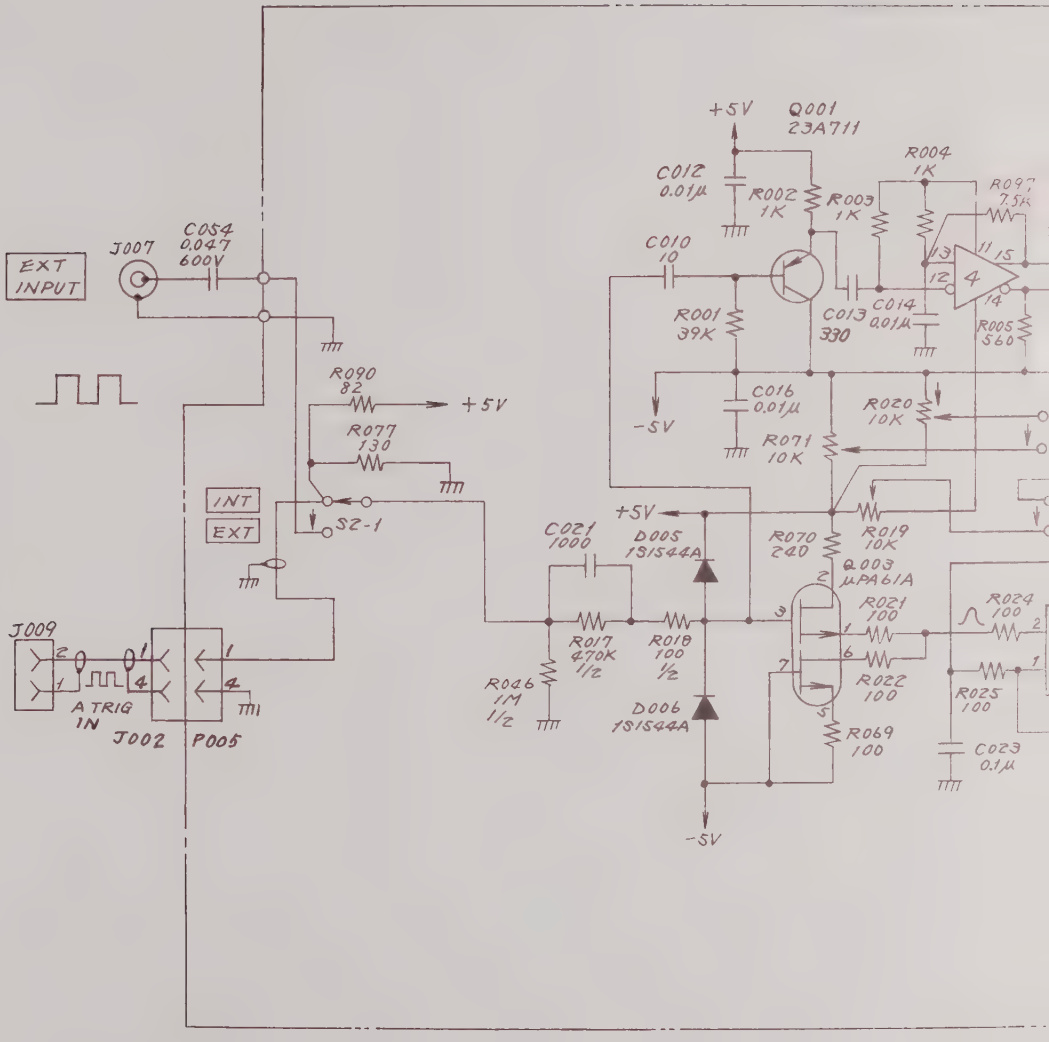
POWER SUPPLY

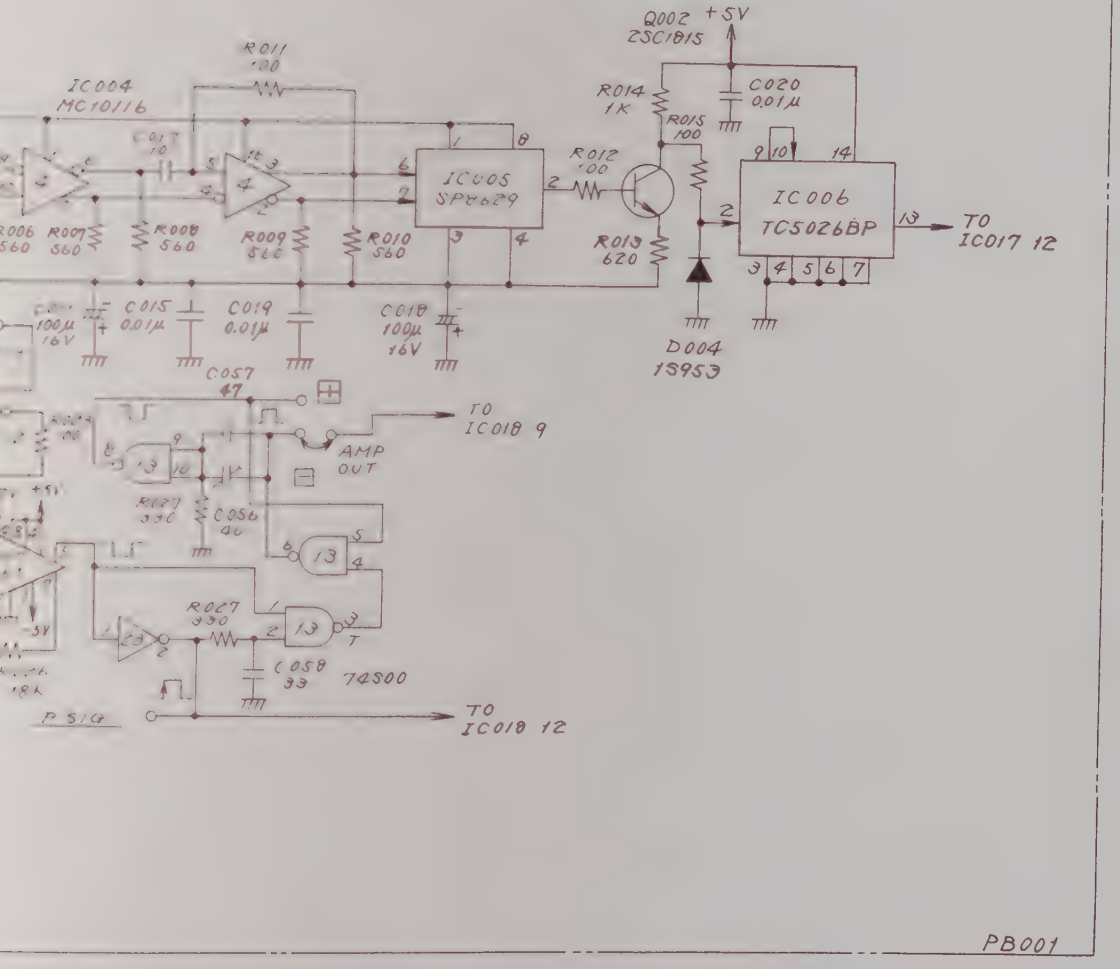


SS-5711/SS-5711C/SS-5711D
SS-5784
POWER SUPPLY & CALIBRATOR

21

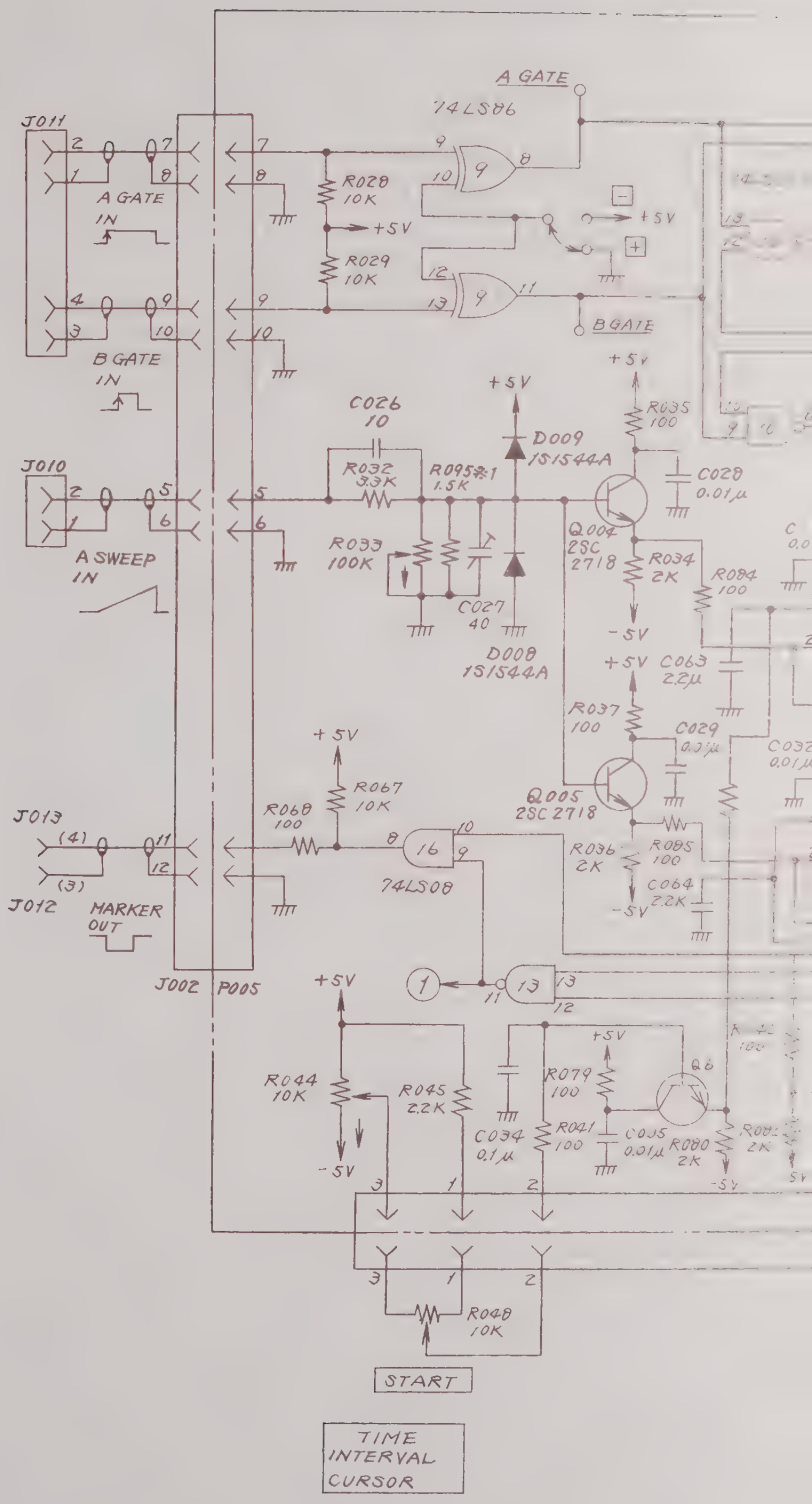
BBWSS08003102 6


EXT INPUT
J007
C054 0.047 600V
R090 82
+5V
R077 130
INT
EXT
S2-1
J009
A TRIG IN
J002
P005
+5V
Q001 2SA711
C012 0.01μ
R002 1K
R003 1K
R004 1K
R097 7.5K
C010 10
R001 39K
C013 330
C014 0.01μ
R005 560
C016 0.01μ
-5V
R071 10K
R020 10K
C021 1000
D005 1S1544A
R070 240
R019 10K
Q003 μPA61A
R017 470K 1/2
R018 100 1/2
R046 1M 1/2
D006 1S1544A
R021 100
R022 100
R069 100
R024 100
R025 100
C023 0.1μ
-5V

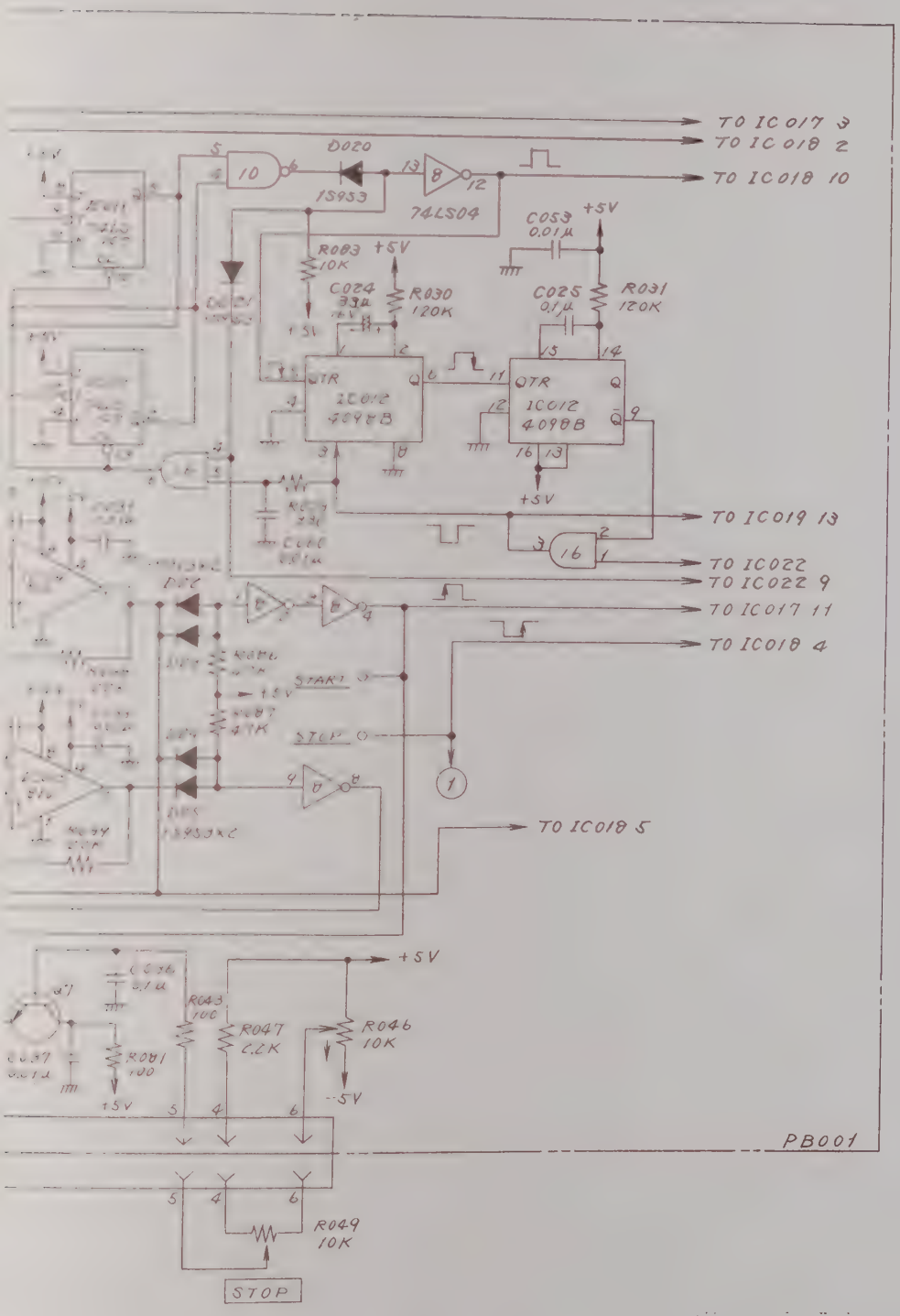


SS-5710C/SS-5710D/SS-5711C/SS-5711D
1/100 PRESCALER & INPUT AMPLIFIER
1

BBWSS 31001106
3



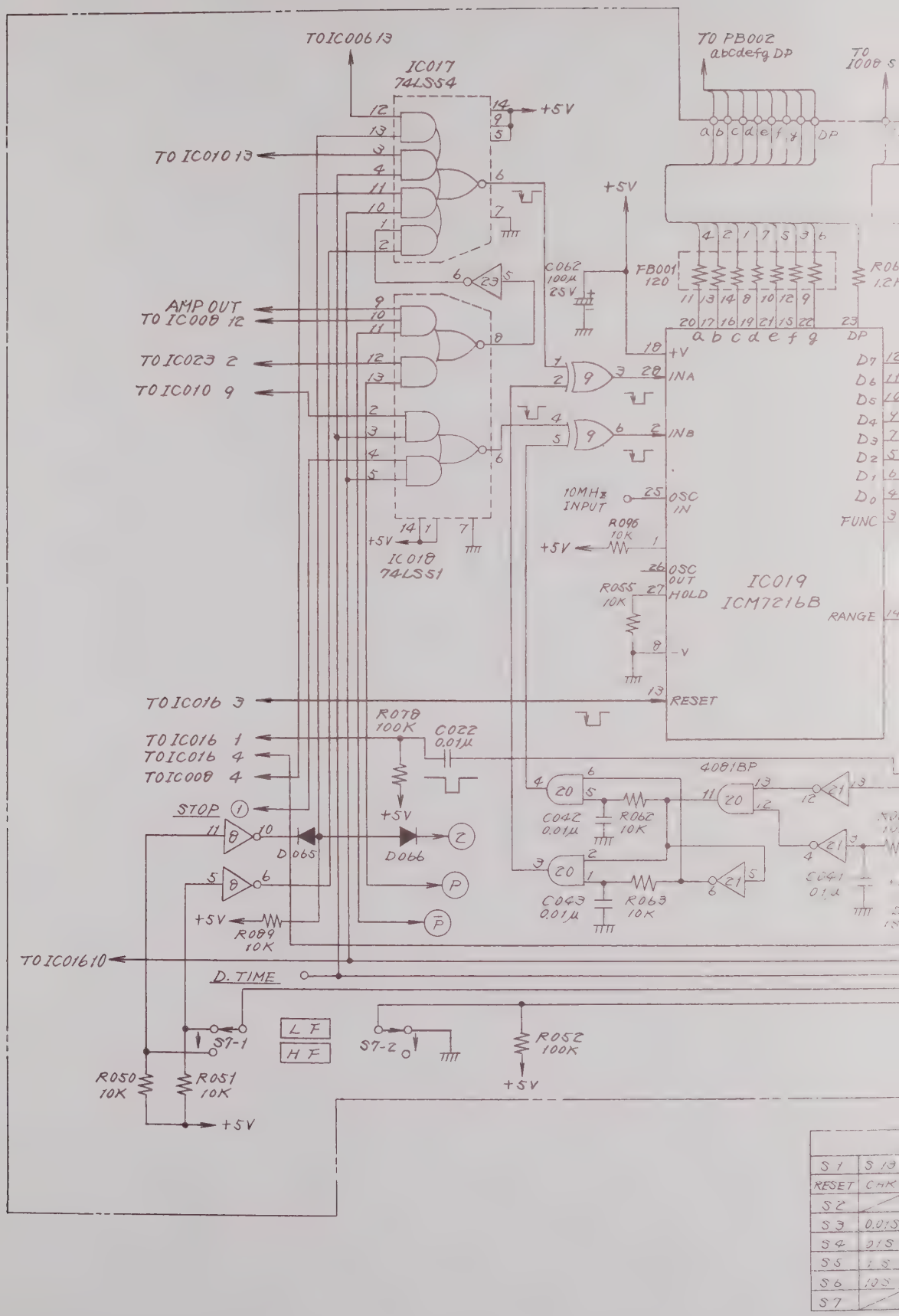
※1 USED SS-5710C/SS-5710D ONLY.



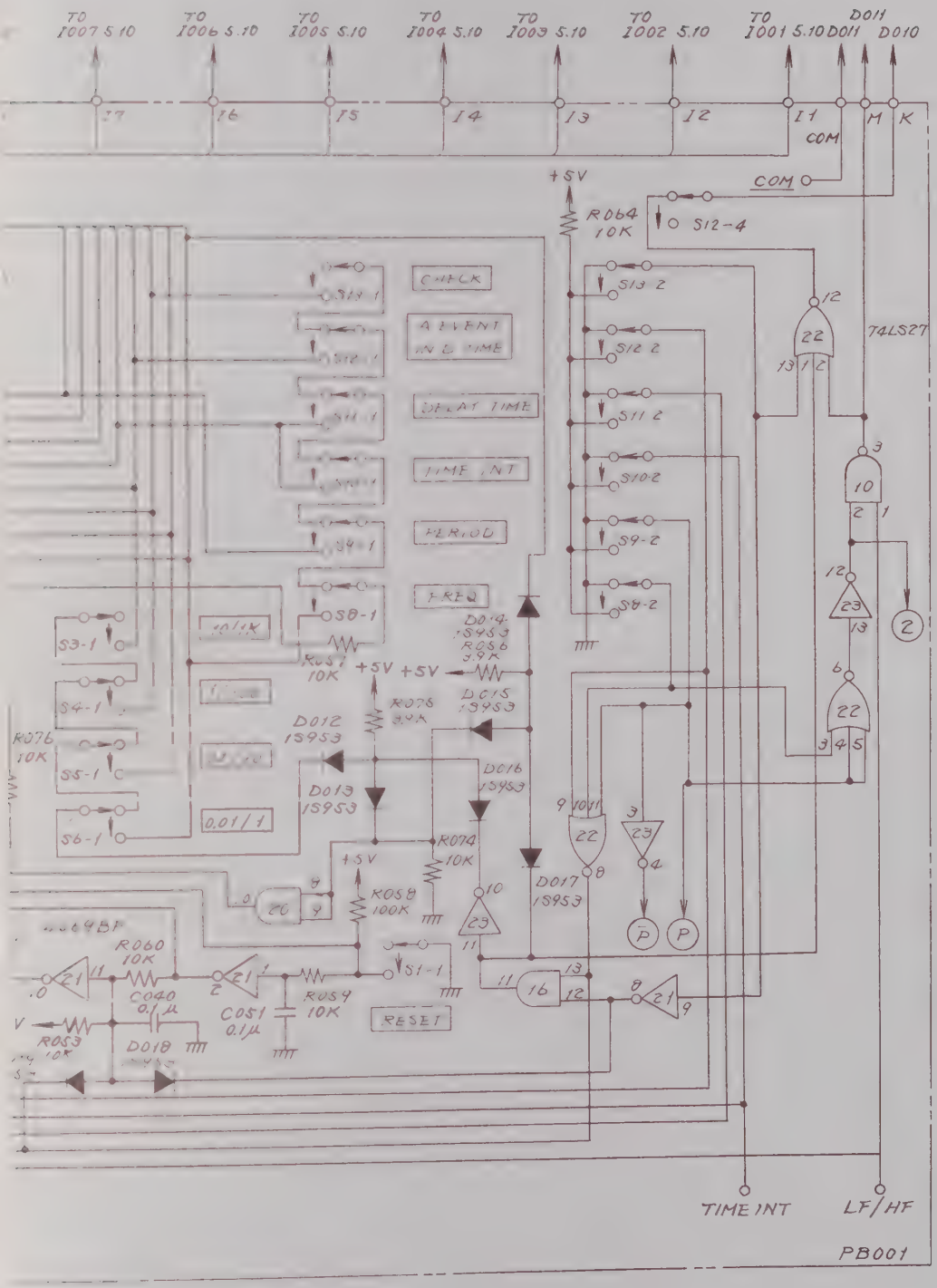
SS-5710C/SS-5710D/SS-5711C/SS-5711D

TIME INTERVAL CONTROL 2

BBWSS31001107 3



S1	S13
RESET	CHK
S2	
S3	0.01S
S4	0.1S
S5	1S
S6	10S
S7	

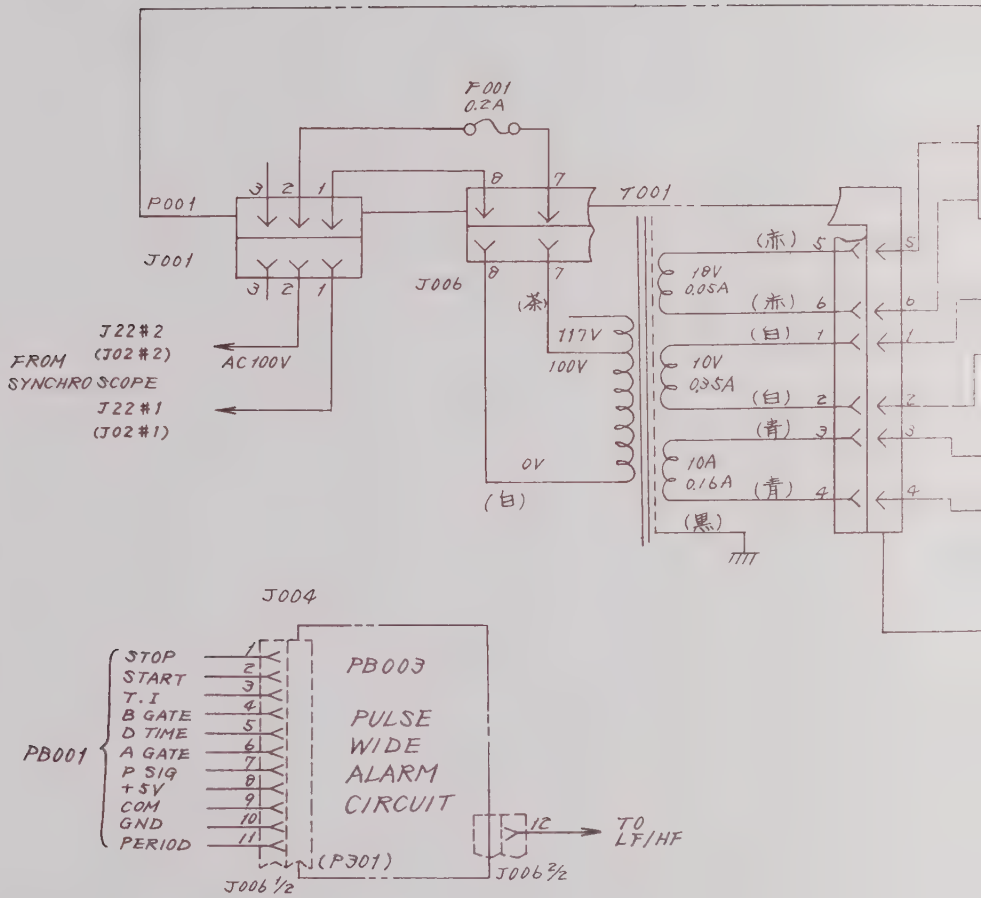


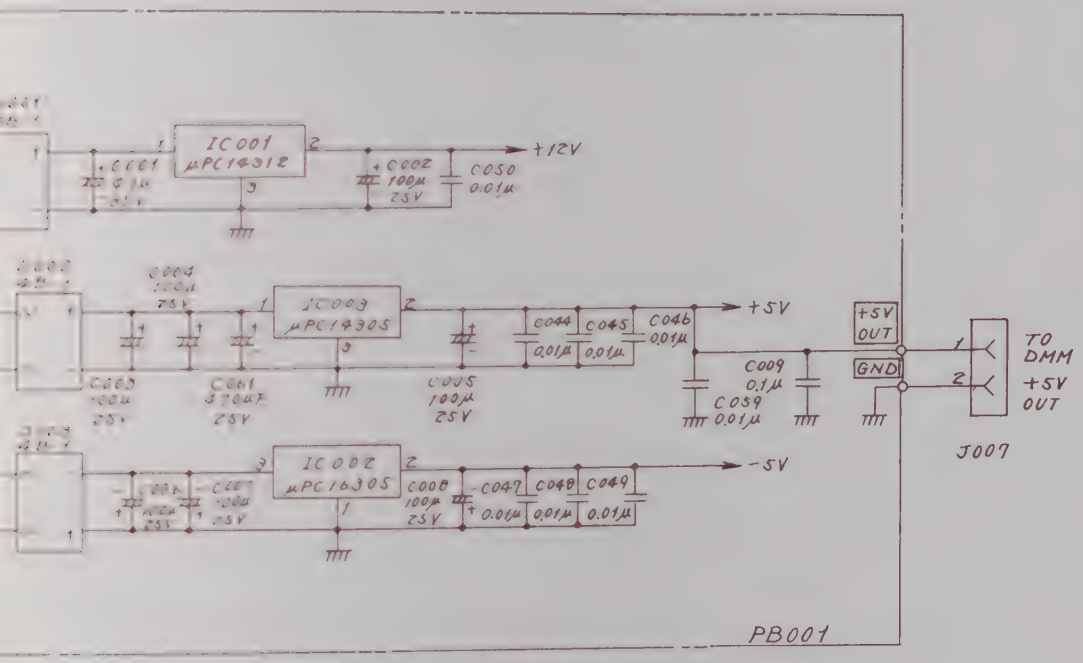
FUNCTION					
S12	S11	S10	S9	S8	
AED1	D.1	1.1	P	F	
			EXT/INT		
		X1		0.01S	RANGE
		X10		0.1S	
		X100		1 S	
		X1K		10 S	
				HF/LF	

SS-5710C/SS-5710D/SS-5711C/SS-5711D

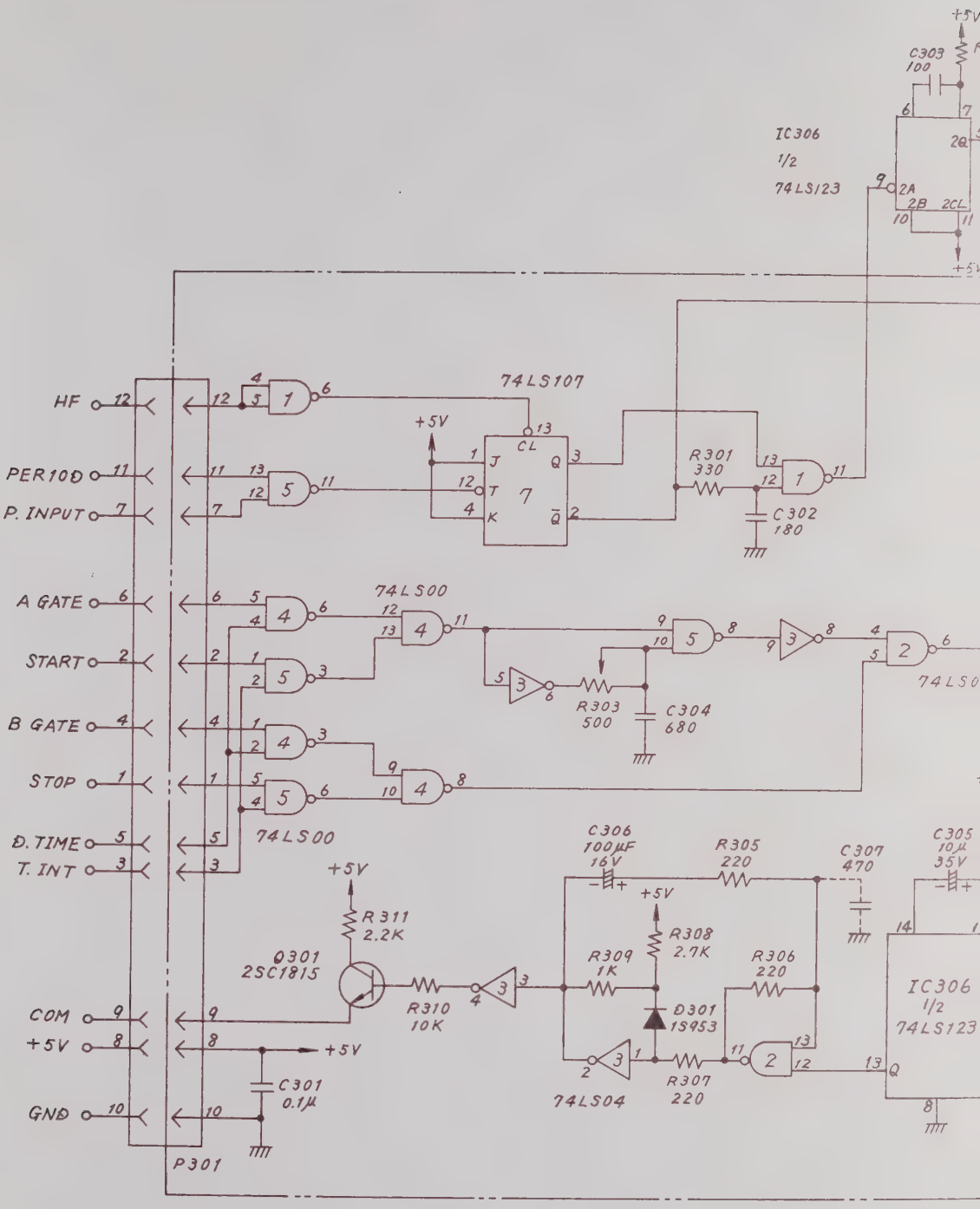
CONTROL 3

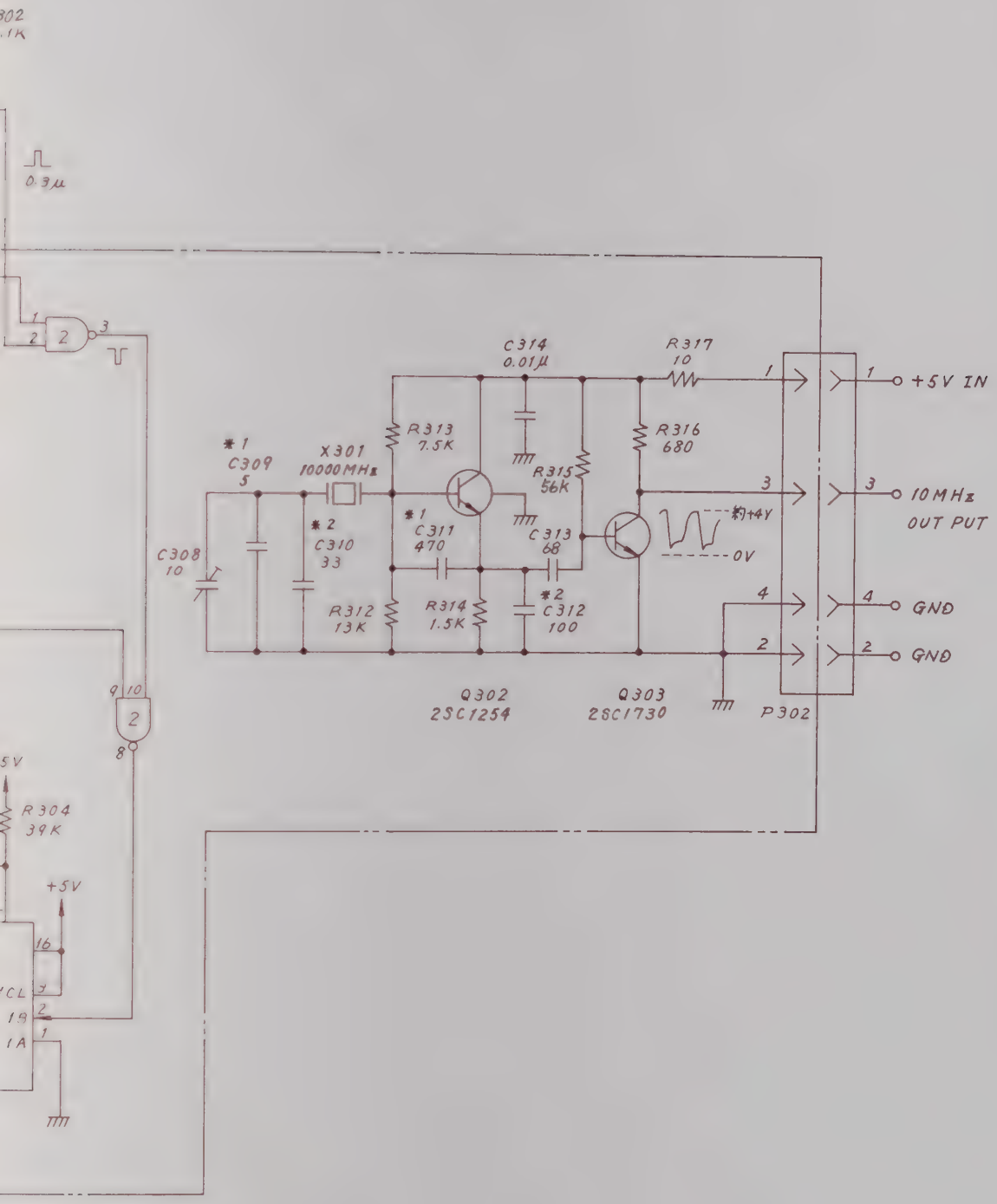
BBWSS31001108 3


F001
0.2A
P001
J001
T001
J006
J22#2
(J02#2)
FROM
SYNCHROSCOPE
J22#1
(J02#1)
AC100V
117V
100V
0V
(白)
(茶)
(赤)
18V
0.05A
10V
0.35A
10A
0.16A
(青)
(黒)
J004
PB001
STOP
START
T.I
B GATE
D TIME
A GATE
P SIG
+5V
COM
GND
PERIOD
PB003
PULSE
WIDE
ALARM
CIRCUIT
(P301)
J006 1/2
J006 2/2
TO
LF/HF

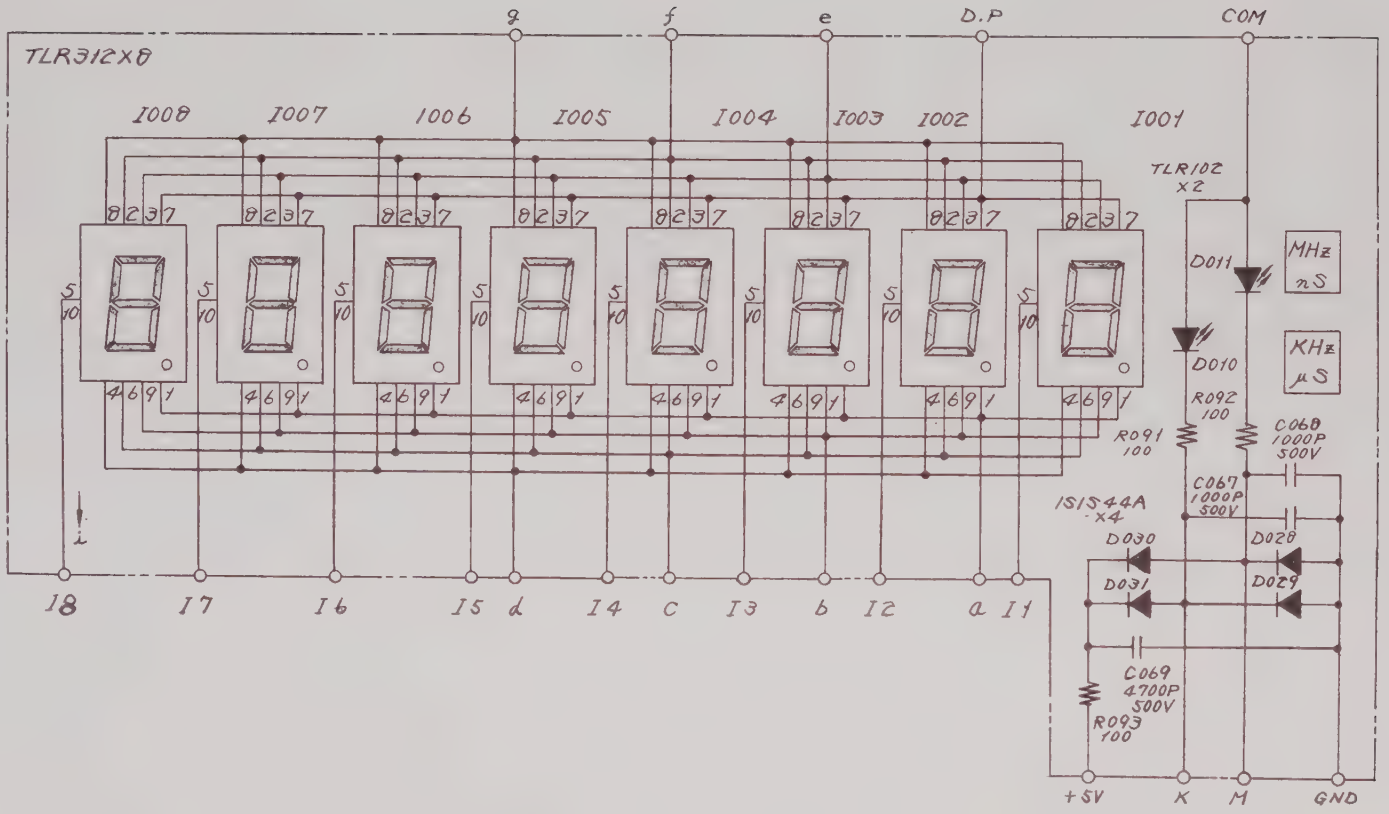


名称	
SS-5710C/SS-5710D/SS-5711C/SS-5711D	
POWER SUPPLY	4
図番	
BBWSS31001109	1

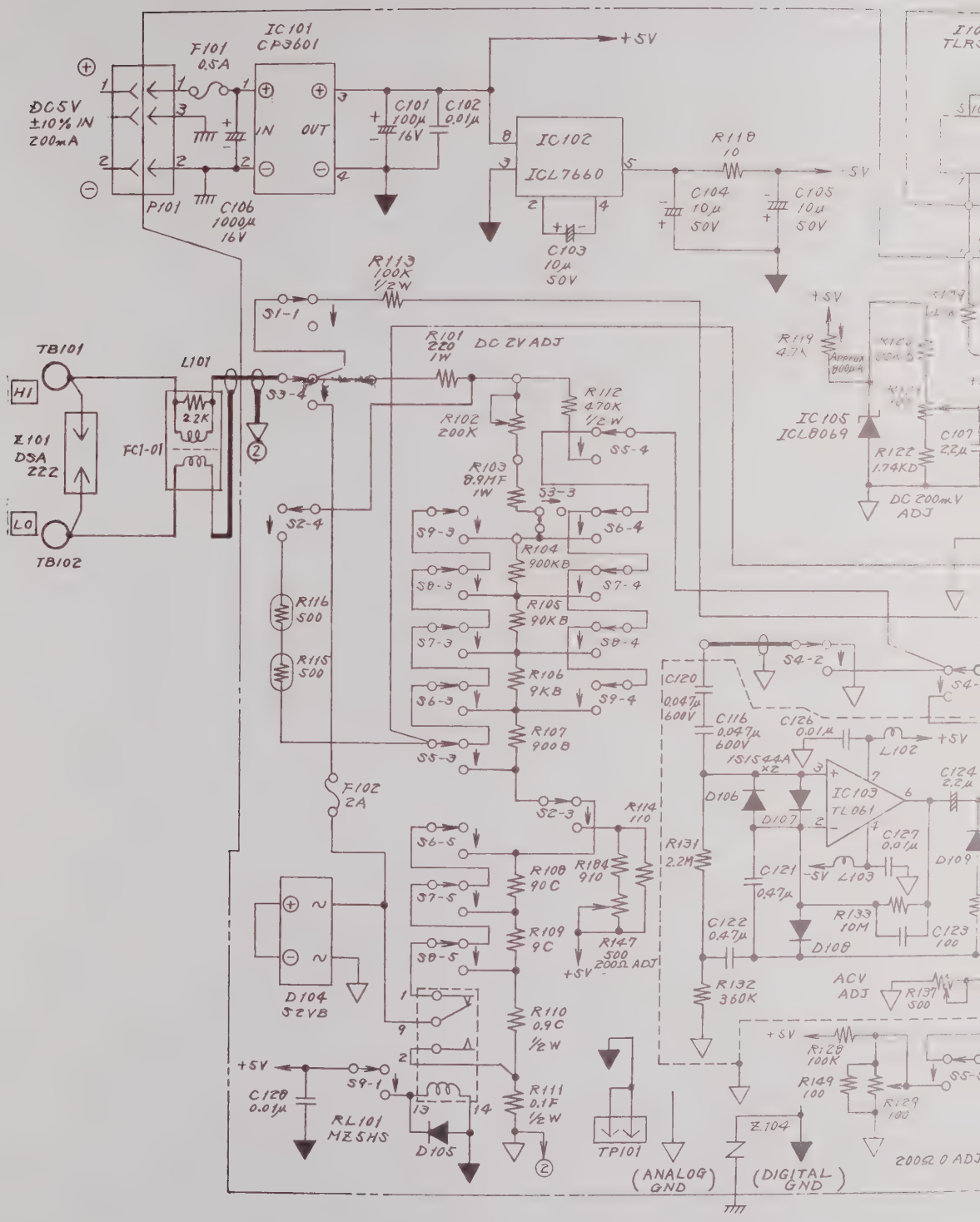

+5V
C303
100
IC306
1/2
74LS123
2A
2B
2CL
2Q
HF
PER10D
P. INPUT
74LS107
CL
J
T
K
Q
R301
330
C302
180
A GATE
START
B GATE
STOP
D. TIME
T. INT
74LS00
R303
500
C304
680
74LS0
C306
100μF
16V
R305
220
C307
470
C305
10μ
35V
R311
2.2K
Q301
2SC1815
R310
10K
R309
1K
R308
2.7K
R306
220
D301
1S953
R307
220
74LS04
IC306
1/2
74LS123
COM
+5V
GND
C301
0.1μ
P301



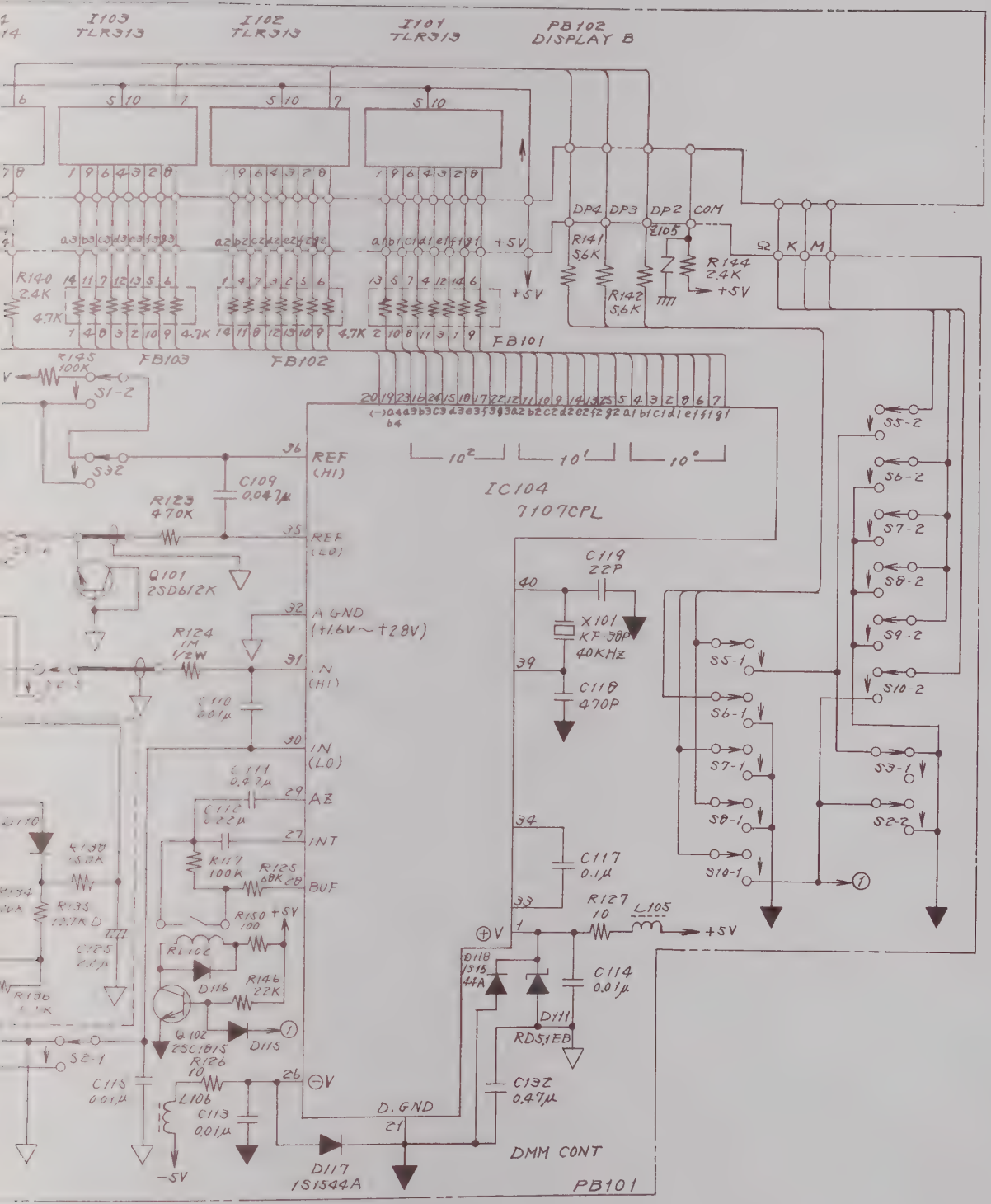
名 称 Title	SS-5710C/SS-5710D/SS-5711C/SS-5711D
	UNIVERSAL COUNTER ALARM 5
図 番 Drwg No.	BBWSS42004110 3



名称
SS-5710C/SS-5710D/SS-5711C/SS-5711D
UNIVERSAL COUNTER DISPLAY A
6
番号
BBWSS41012111
1



- D105, 108, 109, 110, 115, 116 are used of 1S953
- All resistance in ohms 1/4 and all capacitance in picofarads unless otherwise notes.
- : Wiring by shielded-wire
- : ANALOG GND
- : DIGITAL GND



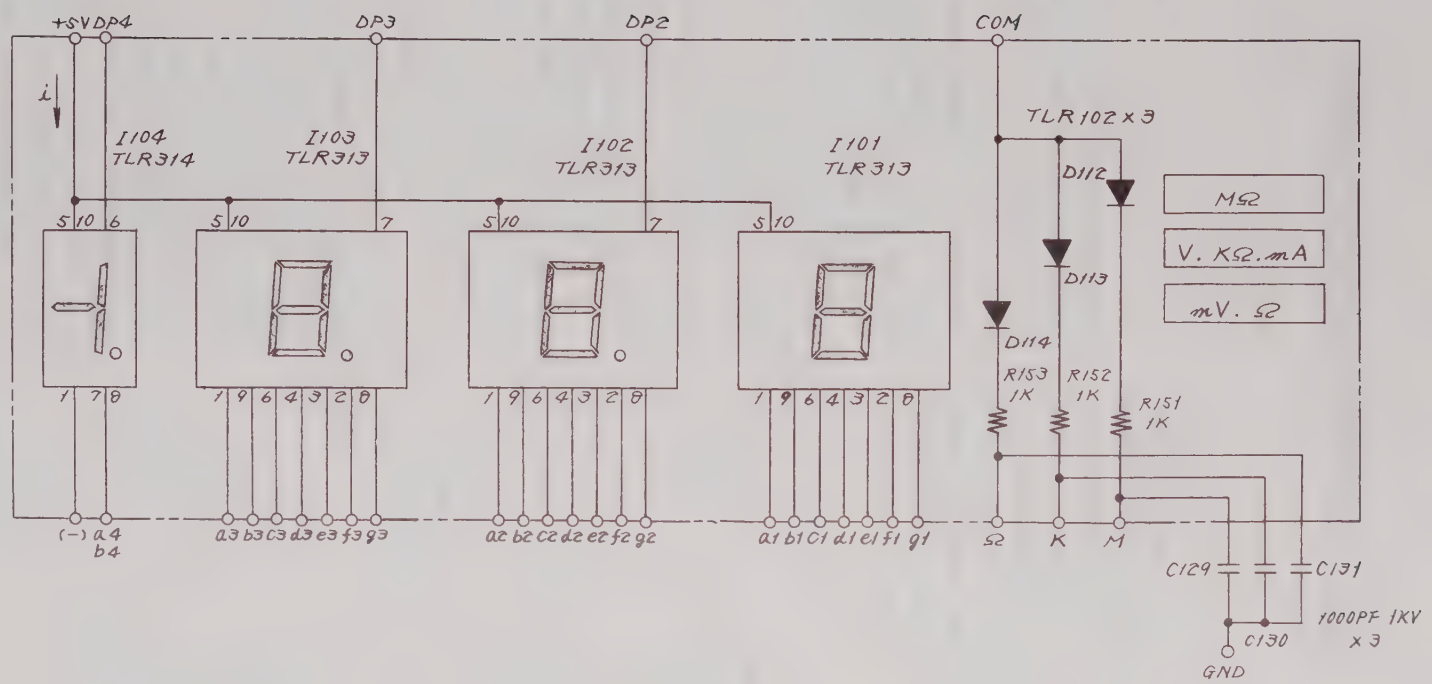
FUNCTION			
S4	S3	S2	S1
AC/DC	A	Ω	V
S5		200 Ω	200mV
S6	2mA	2KΩ	2V
S7	20mA	20KΩ	20V
S8	200mA	200KΩ	200V
S9	2000mA	2000KΩ	1000 AC750 V
S10		20MΩ	

RANGE

SS-5710D/ SS-5711D

DIGITAL MULTIMETER UNIT 1

BBWSS22002106 3



SS-5710D/SS-5711D

DIGITAL MULTIMETER DISPLAY B 2

BBWSS41013106 1

Electrical Parts List

Ordering Information

Replacement parts may be ordered through an IWATSU Representative of directly from the factory. To be certain of receiving the proper parts, a ways include the following information with the order:

a. Model Number and serial number of the instrument on which the parts will be installed.
b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
c. Iwatsu part number.

For factory repair, contact the IWATSU agent and include the following information:

a. Model number and serial number of the instrument on which the work is to be performed.
b. Details concerning the nature of the malfunction, or, type of repair desired.
   Shipping instructions will be sent to you promptly.

How to Use This Parts List

The part list is divided into subsections corresponding to the schematic diagrams such as CH1, CH2 ATTENUATOR & PRE-AMPLIFIER (1), CH1, CH2, PRE-AMPLIFIER (2), DELAY CABLE DRIVER, VERTICAL PANEL SWITCHES, VERTICAL CONTROL, VERTICAL OUTPUT AMPLIFIER, CH3, CH4 PRE-AMPLIFIERS & SOURCE, A, B TRIGGER AMPLIFIER, TV SYNC SEPARATOR, A, B SWEEP GENERATOR, TIMING SWITCHES, HORIZONTAL SWITCHES, HORIZONTAL CONTROL, HORIZONTAL AMPLIFIER, Z AXIS CIRCUIT, CRT CIRCUIT and POWER SUPPLY & CALIBRATOR.

Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to pinpoint malfunctions to the exact replacement parts actually needed and thus avoid the time and cost involved in "over-repair".

Abbreviations

Cap . . . . . .Capacitor
Cer . . . . . .Ceramic
Poly . . . . . .Polyethytel film
Elect. . . . . .Aluminum electrolytic chemical
Elect. tan. . . . . .Tan-talum electrolytic chemical condenser
[The symbol F (farad) is omitted]
Res. . . . . .Resistor
W.W. . . . . .Wire wound
Comp . . . . . .Composition
[The symbol Ω (ohm) is omitted]
FET . . . . . .Field Effect Transistor
Diode . . . . . .
T. diode. . . . . .Tunnel diode
Z. diode. . . . . .Zenner diode
S.B. diode . . . . .Schottky barrier diode
V.C. diode . . . . .Variable capacitance diode
L.E.D. . . . . .Light emission diode
IC. . . . . .Integrated Circuit
Var. . . . . .Variable

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
CH1 ATTENUATOR & PRE-AMPREFIER (1)		
1C01	Cap., 0.047μ ,± 20%, 200V, Poly.	DCF160291
1C02	Cap., 10p, ± 0.5p, 50V, Cer.	DCC231701
1C03	Cap., 0.01μ , +80% ~ –20%, 50V, Cer.	DCC139501
1C11	Cap., 2~8p, Var., 250V, Cer.	DCV019561
1C12	Same as 1C01	
1C13	Same as 1C03	
1C14	Cap., 82p, ±5%, 50V, Cer.	DCC239141
1C15	Cap., 22 μ, ± 20%, 250V, Elect.	DCE229041
1C18	Same as 1C03	
1C19	Same as 1C03	
1C21	Cap., 1p, 0.25p, 50V, Cer.	DCE244711
1C22	Same as 1C15	
1C24	Cap., 2~8p, Var., 250V, Cer.	DCV019612
1C27	Cap., 56p, ±5%, 50V, Cer.	DCC239251
1C41	Same as 1C14	
1C42	Same as 1C15	
1C43	Same as 1C03	
1C44	Same as 1C15	
1C45	Same as 1C15	
1C52	Same as 1C03	
1C54	Same as 1C15	
1C65	Cap., 39p,±5%, 50V, Cer.	DCC239131
1C72	Same as 1C03	
1C73	Same as 1C15	
1C74	Same as 1C03	
1C75	Same as 1C15	
1L01	Magnet Coil, S1283-12V	DCL110531
1R01	Res., 470, ±5%, ¼W, Carbon	DRD139371
1R02	Res., 68, ± 5%, ¼W, Carbon	DRD134551
1R11	Res., 1M, ± 0.5%, ½W, Metal	DRE249041
1R12	Res., 470k, ± 5%, ¼W, Carbon	DRD135471
1R13	Res., 100, ±1%, ¼W, Metal	DRE535251
1R14	Resl 100, ±1%, ¼W, Metal	DRE939561
1R15	Same as 1R13	
1R16	Res., 10k, ±1%, ¼W, Metal	DRE939301
1R17	Res., 27k, ±1%, ¼W, Carbon	DRD134451
1R18	Res., 10k, ±5%, ¼W, Carbon	DRD139161
1R21	Res., 33k, ±1%, ¼W, Carbon	DRD139911
1R22	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
1R23	Same as 1R22	
1R24	Res., 180., ±1%, ¼W, Metal	DRE535311
1R25	Res., 47k, ±1%, ¼W, Carbon	DRD139261
1R26	Res., 560k, ±1%, ¼W, Carbon	DRD139131
1R27	Res., 100, Var, 0.3W, Cermet	DRV412001
1R31	Same as 1R25	
1R32	Same as 1R26	
1R33	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
1R34	Same as 1R13	
1R35	Res., 10k, ±15%, Thermistor	DDD080331
1R36	Same as 1R33	
1R41	Same as 1R14	
1R42	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
1R43	Same as 1R16	
1R44	Same as 1R14	
1R45	Same as 1R18	
1R46	Res., 10k, Var., 0.3W, Cermet	DRV411991
1R51	Res., 560, ±1%, ¼W, Metal	DRE939141
1R52	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
1R53	Same as 1R52	
1R54	Same as 1R51	
1R55	Res., 47k, ± 5%, ¼W, Carbon	DRD139171
1R56	Res., 24, ±1%, ¼W, Metal	DRE939481
1R57	Res., 220, ±1%, ¼W, Metal	DRE939601
1R62	Res., 8.2k, ±5%, ¼W, Carbon	DRD139581
1R63	Res., 5k, Var., 0.3W, Cermet	DRV412051
1R64	Res., 1k, ±1%, ¼W, Metal	DRE939072
1R65	Same as 1R16	
1R66	Same as 1R16	
1R67	Same as 1R16	
1R71	Same as 1R16	
1R72	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
1R73	Same as 1R42	
1R74	Same as 1R57	
1R75	Same as 1R57	
1R76	Res., 470k, ±5%, ¼W, Carbon	DRD139931
1R77	Res., 50k, Var., 0.3W, Cermet	DRV412061

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
1D11	Diode, 1S1544A	DDD010801
1D13	Z.Diode, RD4.7EB1	DDD033131
1D15	Diode, 1S953	DDD010821
1D16	Same as 1D13	
1D74	Z. Diode, RD5.6EB1	DDD031141
1Q11	FET, 2N5912	DTR250011
1Q12	Transistor, 2SC1907	DTR137611
1Q13	Transistor, 2SC2037	DTR137591
1Q14	Same as 1Q13	
1Q15	Same as 1Q13	
1Q16	Same as 1Q13	
1Q17	Transistor, 2SA1206	DTR119041
1Q18	Same as 1Q17	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
1IC11	IC, μPC251C	DIC610091
1S1	Push switch, SUJ20A	DSW014851
1S2	Reed switch, ORD229 (2030)	DKD065891
1S10	Rotary switch, (ADR353-1)	DFB020161
1J1	Connector, BNC 080	DCN040711

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
CH2 ATTENUATOR & PRE-AMPLIFIER (1)		
2C01	Cap., 0.047 μ, ±20%, 200V, Poly.	DCF160291
2C02	Cap., 10p, ±0.5p, 50V, Cer.	DCC231701
2C03	Cap., 0.01μ ,+80% ~–20%, 50V, Cer.	DCC139501
2C11	Cap., 3p, ±0.25p, 500V, Cer.	DCC250701
2C12	Same as 2C01	
2C13	Same as 2C03	
2C14	Cap., 82 p,±5%, 50V, Cer.	DCC239141
2C15	Cap., 22 μ, ±20%, 250V, Elect.	DCE229041
2C18	Same as 2C15	
2C19	Same as 2C15	
2C22	Same as 2C15	
2C24	Cap., 2 ~8p, Var., 250V, Cer.	DCV019612
2C27	Cap., 56p, ±5%, 50V, Cer.	DCC239251
2C41	Same as 2C14	
2C42	Same as 2C15	
2C43	Same as 2C03	
2C44	Same as 2C15	
2C45	Same as 2C15	
2C52	Same as 2C03	
2C65	Cap., 39p, ±5%, 50V, Cer.	DCC239131
2C74	Same as 2C03	
2L01	Magnet coil, S1283-12V	DCL110531
2R01	Res., 470, ±5%, ¼W, Carbon	DRD139371
2R02	Res., 68, ±5%, ¼W, Carbon	DRD134551
2R11	Res., 1M, ±0.5%, ½W, Metal	DRE249041
2R12	Res., 470k, ±5%, ¼W, Carbon	DRD135471
2R13	Res., 100, ±1%, ¼W, Metal	DRE535251
2R14	Res., 100, ±1%, ¼W, Metal	DRE939561
2R15	Same as 2R13	
2R16	Res., 10k, ±1%, ¼W, Metal	DRE939301
2R17	Res., 27k, ±1%, ¼W, Carbon	DRD134451
2R18	Res., 10k, ±5%, ¼W, Carbon	DRD139161
2R21	Res., 33, ±1%, ¼W, Carbon	DRD139911
2R22	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
2R23	Same as 2R22	
2R24	Res., 180, ±1%, ¼W, Metal	DRE535311
2R25	Res., 47, ±1%, ¼W, Carbon	DRD139261
2R26	Res., 560, ±1%, ¼W, Carbon	DRD139121
2R27	Res., 100, Var, 0.3W, Cermet	DRV412001
2R31	Same as 2R25	
2R32	Same as 2R26	
2R33	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
2R34	Same as 2R13	
2R35	Res., 10k, ±15%, Thermistor	DDD080331
2R36	Same as 2R33	
2R41	Same as 2R14	
2R42	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
2R43	Same as 2R16	
2R44	Same as 2R14	
2R45	Same as 2R18	
2R46	Res., 10k, Var., 0.3W, Cermet	DRV411991
2R51	Res., 560,±1%, ¼W, Metal	DRE939141
2R52	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
2R53	Same as 2R52	
2R54	Same as 2R51	
2R55	Res., 47k, ±5%, ¼W, Carbon	DRD139171
2R56	Res., 24, ±1%, ¼W, Metal	DRE939481
2R57	Res., 220, ±1%, ¼W, Metal	DRE939601
2R61	Res., 33k, ±1%, ¼W, Metal	DRE939091
2R62	Res., 8.2,±5%, ¼W, Carbon	DRD139581
2R63	Res., 5k, Var., 0.3W, Cermet	DRV412051
2R64	Res., 1k, ±1%, ¼W, Metal	DRE939071
2R65	Same as 2R16	
2R66	Same as 2R16	
2R67	Same as 2R16	
2R71	Same as 2R16	
2R72	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
2R73	Same as 2R42	
2R74	Same as 2R57	
2R75	Same as 2R57	
2R76	Res., 470k, ±5%, ¼W, Carbon	DRD139931
2R77	Res., 50k, Var., 0.3W, Cermet	DRV412061
2D11	Diode, 1S1544A	DDD010801
2D13	Z. Diode, RD4.7EB1	DDD033131
2D15	Diode, 1S953	DDD010821
2D16	Same as 2D13	
2D74	Z. Diode, RD5.6EB1	DDD031141

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
2Q11	FET, 2N5912	DTR250011
2Q13	Transistor, 2SC2037	DTR250011
2Q14	Same as 2Q13	
2Q15	Same as 2Q13	
2Q16	Same as 2Q13	
2Q17	Transistor, 2SA1206	DTR119041
2Q18	Same as 2Q17	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
2IC11	IC, μPC251C	DIC510091
2S1	Push switch, SUJ20A	DSW014851
2S2	Reed switch, ORD229(2030)	DKD065891
2S10	Rotary switch (ADR353-3)	DFB020161
2J1	Connector, BNC 080	DCN040711

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
CH1 PRE-AMPLIFIER (2)		
3C16	Cap., 1000p, ±10%, 50V, Poly.	DCF129071
3C17	Same as 3C16	
3C21	Cap., 470p, ± 5%, 50V, Cer.	DCC239151
3C22	Cap., 47p,± 5%, 50V, Cer.	DCC239031
3C23	Cap., 2.5 ~22.5p, 250V, Cer.	DCV019592
3C24	Cap., 2 ~12p, 250V, Cer.	DCV019602
3C27	Cap., 0.01μ ,+80%, ~–20%, 50V, Cer.	DCC139501
3C28	Cap., 120p,± 5%, 50V, Cer.	DCC239261
3C32	Same as 3C23	
3C33	Cap., 30p, ± 5%, 50V, Cer.	DCC232701
3C34	Cap., 180p, ±5%, 50V, Cer.	DCC239371
3C35	Same as 3C16	
3C41	Same as 3C27	
3C43	Same as 3C22	
3C45	Cap., 39p,±5%, 50V, Cer.	DCC239131
3C51	Same as 3C27	
3C52	Same as 3C27	
3C61	Cap., 6p, ± 0.5p, 50V, Cer.	DCC239091
3C64	Cap., 22μ , ±30%, 25V, Elect.	DCE229041
3C81	Same as 3C16	
3C90	Cap., 10p, ± 0.5p, 50V, Cer.	DCC239041
3C94	Cap., 39p, ±5%, 50V, Cer.	DCC239131
3C95	Same as 3C16	
3C96	Cap., 100p, ±5%, 50V, Cer.	DCC239051
3C101	Same as 3C27	
3C102	Same as 3C27	
3C103	Cap., 56p, ±5%, 50V, Cer	DCC239251
3C104	Same as 3C27	
3C106	Same as 3C45	
3C107	Same as 3C27	
3R11	Res., 330,± 5%, ¼W, Carbon	DRD139351
3R12	Res., 2.2k, ±1%, ¼W, Metal	DRE535571
3R13	Same as 3R12	
3R14	Res., 22, ±5%, ¼W, Carbon	DRD139261
3R15	Same as 3R14	
3R16	Res., 160, ± 5%, ¼W, Carbon	DRD139111
3R17	Same as 3R17	
3R18	Res., 27k, ±1%, ¼W, Metal	DRE535111
3R19	Same as 3R18	
3R20	Same as 3R18	
3R21	Res., 12k, ±5%, ¼W, Carbon	DRD139601
3R22	Res., 2.7k, ±5%, ¼W, Carbon	DRD139481
3R23	Res., 820, ±5%, ¼W, Carbon	DRD139941
3R24	Res., 500, Var., 0.3W, Cermet	DRV412021
3R25	Res., 120, ±1%, ¼W, Metal	DRE535271
3R26	Res., 470, ±1%, ¼W, Metal	DRE535411
3R27	Same as 3R26	
3R28	Res., 3.9k, ±5%, ¼W, Carbon	DRD139521
3R29	Same as 3R18	
3R31	Res., 47, ±1%, ¼W, Metal	DRE939511
3R32	Res., 100, Var., 0.3W, Cermet	DRV412001
3R33	Res., 510, ±5%, ¼W, Carbon	DRD139381
3R34	Res., 1.3k, ± 5%, ¼W, Carbon	DRD138751
3R35	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
3R41	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
3R42	Res., 68, ±5%, ¼W, Carbon	DRD139841
3R43	Same as 3R18	
3R45	Same as 3R18	
3R46	Same as 3R41	
3R47	Same as 3R32	
3R51	Res., 560, ±1%, ¼W, Metal	DRE939141
3R52	Res., 5.6k, ±1%, ¼W, Metal	DRE939671
3R53	Res., 47, ±5%, ¼W, Carbon	DRD139261
3R54	Res., 560, ±5%, ¼W, Carbon	DRD139121
3R55	Res., 470, ±5%, ¼W, Carbon	DRD139371
3R56	Res., 5k, Var., 0.3W, Cermet	DRV412051
3R57	Same as 3R54	
3R61	Res., 47, ±1%, ¼W, Metal	DRE939511
3R62	Same as 3R61	
3R63	Res., 2.2k, ± 1%, ¼W, Metal	DRE939021
3R64	Res., 680, ± 1%, ¼W, Metal	DRE939631
3R65	Res., 47k, ±1%, ¼W, Metal	DRE535171
3R71	Res., 100, ± 5%, ¼W, Carbon	DRD139291
3R72	Res., 100, ±1%, ¼W, Metal	DRE535251
3R73	Res., 3.3k, ±5%, ¼W, Carbon	DRD139501
3R74	Same as 3R71	
3R75	Same as 3R73	
3R76	Same as 3R65	
3R77	Same as 3R65	
3R81	Res., 150, ±5%, ¼W, Carbon	DRD139101

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
3R82	Res., 470, ±1%, ¼W, Metal	DRE939121
3R83	Res., 1k, Var., 0.3W, Cermet	DRV412031
3R84	Res., 1.5k, ±5%, ¼W, Carbon	DRD139431
3R85	Same as 3R14	
3R86	Res., 390, ±5%, ¼W, Carbon	DRD139361
3R90	Same as 3R11	
3R91	Res., 100, ±1%, ¼W, Metal	DRE939561
3R92	Same as 3R84	
3R93	Same as 3R92	
3R94	Res., 22, ±5%, ¼W, Carbon	DRD139231
3R95	Same as 3R81	
3R96	Same as 3R65	
3R97	Res., 330, ±1%, ¼W, Metal	DRE939621
3R101	Same as 3R55	
3R102	Same as 3R84	
3R103	Res., 39, ±1%, ¼W, Metal	DRE939501
3R104	Same as 3R55	
3R105	Res., 1.2k, ±5%, ¼W, Carbon	DRD139421
3R106	Res., 47, ±5%, ¼W, Carbon	DRD139261
3R107	Res., 4.7k, ±5%, Carbon	DRD139151
3R111	Res., 11.8k, ±5%, ¼W, Carbon	DRD139441
3R112	Same as 3R91	
3R113	Same as 3R24	
3R114	Same as 3R35	
3R115	Same as 3R111	
3R116	Same as 3R107	
3R117	Same as 3R83	
3R118	Same as 3R84	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
3D43	Diode, 1S953,	DDD010821
3D82	Same as 3D43	
3Q11	Transistor, 2SC1907	DTR139061
3Q12	Same as 3Q11	
3Q13	Transistor, 2SC2037	DTR137591
3Q14	Same as 3Q13	
3Q21	Same as 3Q13	
3Q22	Same as 3Q13	
3Q23	Same as 3Q13	
3Q31	Same as 3Q11	
3Q32	Same as 3Q11	
3Q33	Same as 3Q13	
3Q34	Same as 3Q13	
3Q35	Same as 3Q13	
3Q36	Same as 3Q11	
3Q41	Transistor, 2SA1015Y	DTR119011
3Q42	Same as 3Q41	
3Q43	Same as 3Q41	
3J30	Connector, M36-M87-02	DCN034601
3J31	Connector, BNC CH1 OUT	DCN040711
3J50	Connector, M31-M87-10	DCN034531
3J100	Same as 3J30	
3P30	Connector, M36-02-30-1349	DCN034901
3P50	Connector, M33-10-30-114P	DCN034721
3P100	Same as 3P30	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
CH2 PRE-AMPLIFIER (2)		
4C14	Cap., 1000p, ±10%, 50V, Poly.	DCF129071
4C15	Same as 4C14	
4C17	Cap., 0.01μ , +80% −20%, 50V, Cer.	DCC139501
4C21	Cap., 470p, ±5%, 50V, Cer.	DCC239151
4C22	Cap., 47p, ±5%, 50V, Cer.	DCC239031
4C23	Cap., 2.5 ~22.5p, Var., 250V, Cer.	DCV019592
4C24	Cap., 2 ~12p, Var., 250V, Cer.	DCV019602
4C28	Cap., 120p, ±5%, 50V Cer.	DCC239261
4C32	Same as 4C23	
4C33	Cap., 30p, ±5%, 50V, Cer.	DCC232701
4C34	Cap., 180p, ±5%, 50V, Cer.	DCC239271
4C35	Same as 4C14	
4C43	Cap., 47p, ±5%, 50V, Cer.	DCC239031
4C45	Cap., 39p, ±5%, 50V, Cer.	DCC239131
4C46	Same as 4C17	
4C51	Same as 4C17	
4C65	Same as 4C17	
4C67	Same as 4C17	
4C82	Same as 4C33	
4C91	Same as 4C17	
4R8	Res., 47, ±5%, ¼W, Carbon	DRD139261
4R10	Same as 4R8	
4R11	Res., 330, ±5%, ¼W, Carbon	DRD139351
4R12	Res., 2.2k, ±1%, ¼W, Metal	DRE535571
4R13	Same as 4R12	
4R14	Res., 160, ±5%, ¼W, Carbon	DRD139111
4R15	Same as 4R14	
4R16	Res., 470, ±1%, ¼W, Metal	DRE535411
4R17	Same as 4R16	
4R18	Res., 27, ±1%, ¼W, Metal	DRE535111
4R19	Same as 4R18	
4R20	Same as 4R18	
4R21	Res., 12k, ±5%, ¼W, Carbon	DRD139601
4R22	Res., 2.7k, ±5%, ¼W, Carbon	DRD139481
4R23	Res., 620, ±5%, ¼W, Carbon	DRD139131
4R24	Res., 500, Var., 0.3W, Cermet	DRV412021
4R25	Res., 120, ±1%, ¼W, Metal	DRE535271
4R27	Same as 4R18	
4R28	Res., 3.9k, ±5%, ¼W, Carbon	DRD139521
4R31	Res., 47, ±1%, ¼W, Metal	DRE939511
4R32	Res., 100, Var., 0.3W, Cermet	DRV412001
4R33	Res., 430, ±5%, ¼W, Carbon	DRD138741
4R34	Res., 1.3k, ± 5%, ¼W, Carbon	DRD139751
4R35	Res., 10k, ± 5%, ¼W, Carbon	DRD193161
4R41	Res., 2.7k, ± 1%, ¼W, Metal	DRE939651
4R42	Res., 68, ±5%, ¼W, Carbon	DRD139841
4R43	Same as 4R18	
4R45	Same as 4R18	
4R46	Same as 4R41	
4R47	Same as 4R32	
4R50	Res., 47, ±1%, ¼W, Metal	DRE535171
4R51	Res., 560, ±1%, ¼W, Metal	DRE939141
4R52	Res., 5.6k, ±1%, ¼W, Metal	DRE939671
4R53	Same as 4R50	
4R54	Res., 560, ±5%, ¼W, Carbon	DRD139121
4R55	Res., 470, ± 5%, ¼W, Carbon	DRD139371
4R56	Res., 5k, Var., 0.3W. Cermet	DRV412051
4R57	Same as 4R54	
4R58	Res., 47, ±5%, ¼W, carbon	DRD134511
4R59	Same as 4R58	
4R60	Same as 4R50	
4R61	Same as 4R50	
4R62	Same as 4R50	
4R64	Same as 4R50	
4R65	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
4R66	Res., 680, ±1%, ¼W, Metal	DRE939631
4R67	Same as 4R65	
4R68	Same as 4R66	
4R69	Same as 4R50	
4R71	Res., 100, ± 5%, ¼W, Carbon	DRD139291
4R72	Same as 4R71	
4R73	Res., 3.3k, ± 5%, ¼W, Carbon	DRD139501
4R74	Same as 4R71	
4R75	Same as 4R73	
4R76	Same as 4R8	
4R77	Same as 4R8	
4R81	Res., 100, ± 1%, ¼W, Metal	DRE939561
4R82	Res., 15, ± 5%, ¼W, Carbon	DRD139221
4R83	Res., 1.5k, ± 5%, ¼W, Carbon	DRD139431
4R84	Same as 4R83	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
4R85	Res., 470k, ±1%, ¼W, Metal	DRE939121
4R86	Same as 4R83	
4R87	Res., 1k, Var., 0.3k, Cermet	DRV412031
4R90	Same as 4R50	
4R91	Same as 4R55	
4R92	Same as 4R83	
4R93	Same as 4R50	
4D85	Diode, 1S953	DDD010821

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
4Q11	Transistor, 2SC1970	DTR139061
4Q12	Same as 4Q11	
4Q13	Transistor, 2SC2037	DTR137591
4Q14	Same as 4Q13	
4Q21	Same as 4Q13	
4Q22	Same as 4Q13	
4Q23	Transistor, 2SC2073	DTR137631
4Q24	Same as 4Q23	
4Q25	Same as 4Q23	
4Q26	Same as 4Q23	
4Q31	Same as 4Q11	
4Q32	Same as 4Q11	
4Q33	Same as 4Q11	
4Q34	Same as 4Q11	
4Q35	Same as 4Q11	
4J51	Connector, M31-M87-07	DCN034501
4J90	Connector, M36-M87-02	DCN034601
4P51	Connector, M33-07-30-114P	DCN034691
4P90	Connector, M36-02-30-1349	DCN034901

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
DELAY CABLE DRIVER		
5C11	Cap., 100p, ± 5%, 50V, Cer.	DCC239051
5C13	Cap., 14p, ±5%, 50V, Cer.	DCC239221
5C15	Same as 5C11	
5C21	Cap., 0.01μ, +80% −20%, 50V, Cer.	DCC139501
5C26	Cap., 1000p, ±10%, 50V, Poly.	DCF129071
5C27	Same as 5C26	
5C31	Cap., 10p, ± 0.5%, 50V, Cer.	DCC239041
5C32	Cap., 2 ~12p, Var., 250V, Cer.	DCV019581
5C37	Cap., 33p, ±5%, 50V, Cer.	DCC239011
5C41	Same as 5C21	
5C46	Same as 5C26	
5C47	Same as 5C26	
5C51	Cap., 150p, ± 5%, 50V, Cer.	DCC239221
5C52	Cap., 2.5 ~22.5p, Var., 250V, Cer.	DCV019531
5C57	Same as 5C37	
5C82	Cap., 4 ~34p, Var., 250V, Cer.	DCV019541
5C83	Same as 5C26	
5C84	Same as 5C26	
5C85	Cap., 22μ, ±30%, 250V, Elect.	DCE229041
5C91	Same as 5C13	
5C92	Same as 5C13	
5C93	Cap., 150p, ±5%, 50V, Cer.	DCC239011
5C94	Same as 5C93	
5C95	Same as 5C21	
5C112	Same as 5C21	
5DL90	Delay cable, CD -3, 80cm	KHB048111
5R11	Res., 15, ±5%, ¼W, Carbon	DRD139221
5R12	Same as 5R11	
5R13	Same as 5R11	
5R14	Same as 5R11	
5R21	Res., 10k, ±5%, ¼W, Carbon	DRD139161
5R22	Res., 47, ±1%, ¼W, Metal	DRE535171
5R23	Res., 120, ± 5%, ¼W, Carbon	DRD139301
5R24	Same as 5R22	
5R25	Res., 47, ± 5%, ¼W, Carbon	DRD139261
5R26	Res., 330, ±5%, ¼W, Carbon	DRD139351
5R27	Same as 5R26	
5R31	Same as 5R25	
5R32	Res., 120, ±5%, ¼W, Carbon	DRD139301
5R33	Res., 100, Var., 0.3W, Cermet	DRV412001
5R34	Res., 2.2k, ±5%, ¼W, Carbon	DRD139461
5R35	Same as 5R34,	
5R36	Res., 500, Var., 0.3W, Cermet	DRV412021
5R37	Res., 4.7k, ±5%, ¼W, Cermet	DRD139151
5R41	Same as 5R21	
5R42	Same as 5R22	
5R43	Res., 120, ±1%, ¼W, Metal	DRE535271
5R44	Same as 5R22	
5R45	Same as 5R22	
5R46	Same as 5R26	
5R47	Same as 5R26	
5R51	Same as 5R22	
5R52	Same as 5R43	
5R53	Same as 5R33	
5R54	Same as 5R34	
5R55	Same as 5R35	
5R56	Same as 5R36	
5R57	Same as 5R37	
5R61	Same as 5R22	
5R62	Same as 5R22	
5R63	Same as 5R25	
5R64	Same as 5R25	
5R65	Res.,1.2k, ±1%, ¼W, Metal	DRE939291
5R66	Same as 5R65	
5R71	Res., 120, ±1%, ¼W, Metal	DRE939571
5R72	Same as 5R71	
5R73	Res., 1.5k, ±1%, ¼W, Metal	DRE939641
5R74	Same as 5R73	
5R75	Res., 180, ±1%, ¼W, Metal	DRE939591
5R76	Same as 5R75	
5R77	Res., 220, ±1%, ¼W, Metal	DRE939601
5R82	Res., 500, Var., 0.3W, Cermet	DRV412021
5R83	Res., 180, ±5%, ¼W, Carbon	DRD139961
5R84	Same as 5R83	
5R85	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
5R86	Same as 5R85	
5R87A	Res., 10, ±5%, ¼W, Carbon	DRD139211
5R87B	Same as 5R77	
5R88	Same as 5R87A	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
5R91	Same as 5R63	
5R92	Same as 5R63	
5R93	Res., 100k, ±5%, ¼W, Carbon	DRD139751
5R94	Res., 1k,± 5%, ¼W, Carbon	DRD139141
5R95	Same as 5R93	
5R96	Same as 5R94	
5R101	Same as 5R25	
5R102	Same as 5R25	
5R103	Same as 5R94	
5R104	Same as 5R32	
5R105	Same as 5R94	
5R106	Res., 220, ±5%, ¼W, Carbon	DRD139321
5R107	Res., 2.2k,±5%, ¼W, Carbon	DRD139461
5R111	Res., 1k, Var., 0.3W, Cermet	DRV412031
5R112	Res., 470, ±5%, ¼W, Carbon	DRD139371
5R113	Same as 5R25	
5R114	Res., 820, ±5%, ¼W, Carbon	DRD139941
5D11	Diode, 1SS16	DDD010411
5D12	Same as 5D11	
5D13	Diode, 1S953	DDD010821
5D14	Same as 5D13	
5D15	Same as 5D11	
5D16	Same as 5D11	
5D17	Same as 5D13	
5D18	Same as 5D13	
5D61	Same as 5D13	
5D64	Same as 5D13	
5D65	Same as 5D13	
5D68	Same as 5D13	
5D91	Same as 5D13	
5D92	Same as 5D13	
5D93	Same as 5D13	
5D106	Same as 5D13	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
5Q11	Transistor, 2SC2037	DTR137591
5Q12	Same as 5Q11	
5Q13	Same as 5Q11	
5Q14	Same as 5Q11	
5Q21	Same as 5Q11	
5Q22	Same as 5Q11	
5Q23	Transistor, 2SA1206	DTR119041
5Q24	Same as 5Q23	
5Q25	Same as 5Q23	
5Q61	Transistor, 2SC1834	DTR131031
5Q62	Same as 5Q61	
5J21	Connector, M36-M87-03	DCN034611
5J41	Same as 5J21	
5J100	Connector, M36-M87-02	DCN034601
5P21	Connector, M36-03-30-134P	DCN034911
5P41	Same as 5P21	
5P91	Connector, M33-04-30- 114P	DCN034661
5P100	Connector, M36-02-30-134P	DCN034901

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
VERTICAL PANEL SWITCHES		
6C11	Cap., 0.01μ, +80%, ~ −20%, 50V, Cer.	DCC139501
6C31	Same as 6C11	
6C41	Same as 6C11	
6R11	Res., 10k, ±5%, ¼W, Carbon	DRD139161
6R12	Res.,1k, ±5%, ¼W, Carbon	DRD139141
6R13	Same as 6R12	
6R14	Same as 6R11	
6R15	Same as 6R11	
6R21	Res., 3.3k, ±5%, ¼W, Carbon	DRD139501
6R22	Res., B5k, Var., 0.05W, Carbon	DRV147381
6R23	Res., 1.8k, ±5%, ¼W, Carbon	DRD139441
6R24	Same as 6R21	
6R25	Same as 6R22	
6R26	Same as 6R23	
6R31	Same as 6R11	
6R32	Same as 6R12	
6R33	Same as 6R12	
6R34	Same as 6R11	
6R35	Same as 6R11	
6R41	Res., 4.7k, ±5%, ¼W, Carbon	DRD139151
6R42	Same as 6R41	
6R43	Same as 6R23	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
6D11	L.E.D., TLR206	DDD070101
6D12	Same as 6D11	
6D13	Same as 6D11	
6D14	Diode, 1S953	DDD010821
6D31	Same as 6D14	
6D41	Same as 6D14	
6D42	Same as 6D14	
6Q11	Transistor, 2SC1815GR	DTR139011
6Q12	Same as 6Q11	
6Q31	Same as 6Q11	
6Q32	Same as 6Q11	
6Q41	Same as 6Q11	
6S12	Push switch, SVJ12A,	DSW014831
6S20	Same as 6S12	
6J21	Connector, M31-M87-10	DCN034531
6J22	Connector, M31-M87-08	DCN034511
6P21	Connector, M33-10-30-134P	DCN034821
6P22	Connector, M33-08-30-134P	DCN034801

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
VERTICAL CONTROL		
7C10	Cap., 0.01μ,+80%~−20%, 50V, Cer.	DCC139501
7C12	Cap., 100 p, ±5%, 50V, Cer.	DCC239051
7C13	Same as 7C10	
7C14	Same as 7C10	
7C15	Same as 7C10	
7C16	Cap., 33μ, ±20%, 16V, Elect.	DCE229011
7C17	Same as 7C16	
7C18	Same as 7C10	
7C21	Same as 7C10	
7C22	Same as 7C12	
7C23	Same as 7C12	
7C24	Cap., 570P, ±5%, 50V, Cer.	DCC239151
7C25	Cap., 330P, ±5%, 50V, Cer.	DCC239181
7C31	Cap., 27P, ±5%, 50V, Cer.	DCC239241
7C41	Same as 7C31	
7C45	Cap., 22μ, ±20%, 25V, Elect.	DCE229041
7C70	Same as 7C10	
7C71	Same as 7C45	
7C72	Same as 7C10	
7R21	Res., 8.2k, ±5%, ¼W, Carbon	DRD139581
7R22	Res., 1.8k, ± 5%, ¼W, Carbon	DRD139441
7R23	Same as 7R21	
7R24	Same as 7R22	
7R25	Res., 1.5k, ±5%, ¼W, Carbon	DRD193431
7R26	Res., 560, ±5%, ¼W, Carbon	DRD139121
7R27	Res., 1k, ±5%, ¼W, Carbon	DRD139141
7R31	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
7R32	Res., 4.7k, ±1%, ¼W, Metal	DRE939471
7R33	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
7R34	Res., 100, ±5%, ¼W, Carbon	DRD139291
7R35	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
7R41	Same as 7R31	
7R42	Same as 7R32	
7R43	Same as 7R33	
7R44	Same as 7R34	
7R45	Same as 7R35	
7R51	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
7R52	Same as 7R32	
7R53	Same as 7R33	
7R54	Same as 7R34	
7R55	Same as 7R35	
7R61	Same as 7R51	
7R62	Same as 7R32	
7R63	Same as 7R33	
7R64	Same as 7R34	
7R65	Same as 7R35	
7RA1	Resistor, Array, 8-22-kΩJ	DFB015641
7Q11	Transistor, 2SC1815GR	DTR139011
7Q12	Same as 7Q11	
7Q13	Same as 7Q11	
7Q14	Same as 7Q11	
7Q15	Same as 7Q11	
7IC1	IC, SN74LS26N	DIC140271
7IC2	IC, SN74LS00N	DIC140041
7IC3	IC, SN74LS11N	DIC140121
7IC4	Same as 7IC1	
7IC5	IC, SN74LS04N	DIC140051
7IC6	IC, SN74LS112N	DIC141111
7S10	Push switch, SUJ50A	DSW014921
7J11	Connector, M36-M87-06	DCN034641
7J12	Same as 7J11	
7J20	Connector, M36-M87-04	DCN034621
7J51	Connector, M36-M87-05	DCN035631
7P11	Connector, M36-06-30-114P	DCN034891
7P12	Same as 7P11	
7P20	Connector, M36-04-30-114P	DCN034871
7P51	Connector, M36-05-30-114P	DCN034881

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
VERTICAL OUTPUT AMPLIFIER		
8C11	Cap., 0.01 μ,+80%~–20%, 50V, Cer.	DCC139501
8C12	Cap., 4p, +80%~–20%, 50V, Cer.	DCC239201
8C13	Same as 8C12	
8C21	Cap., 1000p, ±10%, 50V, Poly.	DCF129071
8C22	Same as 8C21	
8C23	Cap., 33p, +80%~–20%, 50V, Cer.	DCC239011
8C26	Same as 8C11	
8C28	Same as 8C21	
8C31	Same as 8C11	
8C33	Same as 8C23	
8C40	Cap., 10p, +80%~–20%, 50V, Cer.	DCC239041
8C41	Cap., 22 μ +100%~–10%, 25V, Elect.	DCE229041
8C42	Same as 8C11	
8C45	Same as 8C21	
8C46	Same as 8C21	
8C51	Cap., 43P, +80%~–20%, 50V, Cer.	DCC239291
8C53	Cap., 2.5~20.5P, Var., 250V, Cer.	DCV019531
8C54	Cap., 2~12p, Var., 250V, Cer.	DCV019581
8C56	Same as 8C41	
8C57	Same as 8C11	
8C61	Same as 8C11	
8C82	Same as 8C21	
8C83	Same as 8C21	
8C84	Same as 8C21	
8C86	Same as 8C21	
8C91	Same as 8C11	
8C92	Same as 8C11	
8C93	Same as 8C11	
8L11	Matching coil	DCL150381
8L12	Same as 8L11	
8L91	Peaking coil	DCL151301
8L92	Same as 8L91	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
8R9	Res., 390, ±5%, ¼W, Carbon	DRD134731
8R10	Res., 5k, Var., 0.3W, Cermet	DRV412051
8R11	Res., 120, ±1%, ¼W, Metal	DRE130611
8R12	Same as 8R11	
8R13	Res., 47, ±5%, ¼W, Carbon	DRD139261
8R14	Same as 8R13	
8R15	Res., 68, ±1%, ¼W, Metal	DRE939531
8R16	Same as 8R15	
8R17	Res., 10k, ±15%, Thermistor	DDD080431
8R21	Res., 470, ±5%, ¼W, Carbon	DRD139371
8R22	Same as 8R21	
8R23	Res., 22k, ±5%, ¼W, Carbon	DRD139641
8R24	Res., 100,± 5%, Carbon	DRD139291
8R25	Res., 91, ±1%, ¼W, Metal	DRE939551
8R26	Same as 8R15	
8R27	Res., 1.5k, ±5%, ¼W, Carbon	DRD139431
8R28	Same as 8R24	
8R31	Res., 10k, Var., 0.3W, Cermet	DRV411991
8R32	Res., 4.7k, ±5%, ¼W, Carbon	DRD193151
8R33	Res., 10k,± 5%, ¼W, Carbon	DRD193161
8R34	Same as 8R13	
8R35	Res., 1.8k, ±5%, ¼W, Carbon	DRD139441
8R36	Same as 8R24	
8R40	Res., 330,± 5%, ¼W, Carbon	DRD139351
8R41	Same as 8R13	
8R42	Res., 120, ±1%, ¼W, Metal	DRE939571
8R43	Same as 8R42	
8R44	Same as 8R13	
8R45	Same as 8R24	
8R46	Same as 8R24	
8R47	Res., 1k,± 5%, ¼W, Carbon	DRD134831
8R51	Same as 8R32	
8R52	Res., 180, ±5%, ¼W, Metal	DRE939591
8R53	Res., 2.2k. ±5%, ¼W, Carbon	DRD139461
8R54	Res., 500, Var., 0.3W, Cermet	DRV412021
8R55	Res., 390, ±1%, ½W, Metal	DRE949011
8R56	Same as 8R55	
8R61	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
8R62	Res., 470, ±1%, ¼W, Metal	DRE939121
8R63	Res., 330, ±1%, ¼W, Metal	DRE939621
8R64	Res., 1k, Var., 0.3V, Cermet	DRV412031
8R65	Same as 8R42	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
8R66	Same as 8R42	
8R67	Res., 27, ±5%, ¼W, Carbon	DRD139071
8R68	Same as 8R67	
8R71	Res., 1.5k,± 1%, ¼W, Metal	DRE939641
8R72	Res., 5.6k, ±1%, ¼W, Metal	DRE939671
8R73	Res., 47, ±5%, ¼W, Carbon	DRD139261
8R74	Res., 330, ±1%, ¼W, Metal	DRE939621
8R75	Res., 39,±1%, ¼W, Metal	DRE939501
8R76	Same as 8R74	
8R77	Same as 8R73	
8R81	Res., 22, ±5%, ¼W, Carbon	DRD139231
8R82	Same as 8R52	
8R83	Res., 150,±1%, ¼W, Metal	DRE939581
8R84	Same as 8R52	
8R85	Same as 8R81	
8R86	Same as 8R83	
8R91	Same as 8R75	
8R92	Res., 270, ±1%, ¼W, Metal	DRE939611
8R93	Same as 8R92	
8R94	Res., 270,±5%, ¼W, Carbon	DRD139331
8R95	Res., 180,±5%, ¼W, Carbon	DRD139961
8R96	Same as 8R95	
8R101	Res., 120,±2%, 1W, Metal	DRE153511
8R102	Res., 240,±2%, 2W, Metal	DRE163581
8R103	Same as 8R102	
8R104	Same as 8R101	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
8D11	Diode, 1SV69	DDD019011
8D12	Diode, 1S953	DDD010821
8D41	Z.Diode, RD7.5EB	DDD031811
8D81	Z. Diode, RD4.7EB1	DDD033131
8D85	Same as 8D81	
8Q11	Transistor, 2SA800	DTR115701
8Q12	Same as 8R11	
8Q13	Transistor, 2SA1206	DTR119041
8Q14	Same as 8Q13	
8Q15	Transistor, 2SC1907	DTR139061
8Q16	Transistor, 2SA1015Y	DTR119011
8Q21	Transistor, 2SC2408	MHN000481
8Q22	Same as 8Q21	
8Q23	Same as 8Q21	
8Q24	Same as 8Q21	
8Q25	Same as 8Q21	
8Q26	Same as 8Q21	
8Q27	Transistor, 2SC1815GR	DTR139011
8Q31	Same as 8Q21	
8Q32	Same as 8Q21	
8Q33	Transistor, 2SC1412	DTR130901
8Q34	Same as 8Q33	
8P11	Connector, M33-04-30-114P	DCN034661

CH3 & CH4PRE—AMPLIFIER & SOURCE

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
9C1	Cap., 0.47μ, ±20%, 200V, Poly.	DCF160291
9C2	Cap., 2~12p, Var., 250V, Cer.	DCV019581
9C3	Same as 9C2	
9C4	Cap., 47p, ± 5%, 100V, Cer.	DCC249511
9C5	Cap., 22p, ± 5%, 50V, Cer.	DCC239121
9C7	Cap., 27p, ± 5%, 300V, Mica	DCM252311
9C8	Same as 9C2	
9C21	Same as 9C1	
9C22	Cap., 2 ~12p, Var., 250V, Cer.	DCV019581
9C23	Same as 9C22	
9C24	Same as 9C4	
9C25	Same as 9C5	
9C27	Same as 9C7	
9C28	Same as 9C22	
9C41	Cap., 0.01μ ,+80%~ −20%, 50V, Cer.	DCC139501
9C42	Cap., 56p, +80% ~−20%, 50V, Cer.	DCC239251
9C43	Cap., 57p, ±20%, 25V, Elect.	DCE229061
9C45	Same as 9C41	
9C51	Same as 9C41	
9C54	Same as 9C41	
9C57	Same as 9C41	
9C58	Same as 9C41	
9C62	Same as 9C41	
9C63	Same as 9C43	
9C71	Same as 9C41	
9C72	Same as 9C42	
9C73	Same as 9C41	
9C74	Same as 9C41	
9C75	Same as 9C41	
9C81	Same as 9C41	
9C84	Same as 9C41	
9C85	Same as 9C43	
9C87	Same as 9C41	
9C88	Same as 9C41	
9C91	Same as 9C43	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
9R1	Res., 470, ±5%, ¼W, Carbon	DRD139371
9R3	Res., 900k, ±0.5%, ½W, Metal	DRE249031
9R4	Res., 111k, ±0.5%, ¼W, Metal	DRE239011
9R5	Res., 180, ±5%, ¼W. Carbon	DRD139961
9R6	Res., 82, ±5%, ¼W, Carbon	DRD139981
9R7	Res., 500k, ±0.5%, ½W, Metal	DRE249021
9R8	Res., 22, ±1%, ¼W, Metal	DRE535091
9R21	Same as 9R1	
9R23	Same as 9R3	
9R24	Same as 9R4	
9R25	Same as 9R5	
9R26	Same as 9R6	
9R27	Same as 9R7	
9R28	Same as 9R8	
9R40	Res., 500k, ± 0.5%, ½W, Metal	DRE249021
9R41	Res., 47, ± 5%, ¼W, Carbon	DRD139261
9R42	Res., 100, ±1%, ¼W, Metal	DRE939561
9R43	Same as 9R41	
9R44	Res., 47, ±1%, ¼W, Metal	DRE939511
9R45	Res., 100, Var., 0.3W, Cermet	DRV412121
9R46	Same as 9R45	
9R51	Res., 22, ± 5%, ¼W, Carbon	DRD139231
9R52	Res., 1.2k, ±1%, ¼W, Metal	DRE939291
9R53	Same as 9R52	
9R54	Same as 9R44	
9R55	Same as 9R44	
9R56	Res., 150, ±1%, ¼W, Metal	DRE939581
9R57	Res., 3.3k, ± 1%, ¼W, Metal	DRE939661
9R58	Res., 20k, Var., 0.05W, Carbon	DRV131411
9R62	Same as 9R41	
9R63	Same as 9R44	
9R64	Same as 9R44	
9R67	Same as 9R57	
9R68	Same as 9R41	
9R70	Same as 9R40	
9R71	Same as 9R41	
9R72	Same as 9R42	
9R73	Same as 9R41	
9R81	Same as 9R51	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
9R82	Same as 9R52	
9R83	Same as 9R52	
9R85	Res., 47, ±1%, ¼W, Metal	DRE939511
9R86	Same as 9R56	
9R87	Same as 9R57	
9R88	Same as 9R58	
9R98	Same as 9R41	
9D41	Diode 1S1544A	DDD010801
9D71	Same as 9Q51	
9D74	Diode, RD5.6EBI	DDD031141
9Q41	Twin-transistor, μPA61AM	DTR295281
9Q51	Transistor, 2N3905	DTR150011
9Q53	Tranaistor, 2SC2037	DTR137591
9Q57	Transistor, 2SC1907	DTR137611
9Q71	Same as 9Q41	
9Q81	Same as 9Q51	
9Q83	Same as 9Q53	
9Q87	Same as 9Q57	
9S1	Coupling switch, SUJ25A	DSW014861
9S22	Same as 9S1	
9S61	Push switch, SUJ45A	DSW014901
9S91	Same as 9S61	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
9J1	Connector, BNC	DCN040711
9J2	Connector, M31C8-4	DCN034501
9J3	Same as 9J2	
9J21	Same as 9J1	
9J22	Same as 9J2	
9J23	Same as 9J2	
9J51	Connector, M36-M87-06	DCN034641
9J61	Connector, M36-M87-03	DCN034611
9J81	Connector, M36-M87-04	DCN034621
9J91	Same as 9J61	
9P2	Connector, M36-02-30-134P	DCN034901
9P3	Same as 9P2	
9P22	Same as 9P2	
9P23	Same as 9P2	
9P51	Connector, M36-06-30-134P	DCN034941
9P61	Connector, M36-03-134P	DCN034911
9P81	Connector M36-06-30-134P	DCN034921
9P91	Same as 9P61	

A TRIGGER AMPLIFIER

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO
10C1	Cap., 1 μ, +150%~−10%, 50V, Elect.	DCE244711
10C3	Cap., 47 μ, +150%~−10%, 25V, Elect	DCE229061
10C2	Cap., 2200p, ±10%, 50V, Poly	DCF129061
10C12	Cap., 0.1 μ, ±10%, 50V, Poly	DCF129601
10C15	Cap., 56p, ±5%, 50V, Cer.	DCC239051
10C23	Cap., 0.01μ , ±10%, 50V, Cer.	DCC133571
10C32	Cap., 56p, ±5%, 50V, Cer.	DCC239251
10C36	Cap., 0.01 μ, ±10%, 500V, Cer.	DCC139501
10C38	Same as 10C36	
10C55	Same as 10C36	
10C64	Cap., 33p, ±5%, 50V, Cer.	DCC239011
10C72	Same as 10C36	
10C81	Same as 10C3	
10C82	Same as 10C36	
10C83	Same as 10C3	
10C84	Same as 10C36	
10C85	Same as 10C3	
10C86	Same as 10C36	
10C87	Same as 10C36	
10R3	Res., 22k, ±1%, ¼W, Metal	DRE939061
10R4	Res., 3.3k, ±1%, ¼W, Metal	DRE939661
10R5	Res., 18k, ±1%, ¼W, Metal	DRE939351
10R6	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
10R7	Res., 10k, ±1%, ¼W, Metal	DRE939301
10R8	Same as 10R7	
10R9	Res., 50k, Var., 0.2W, Carbon	DRV146811
10R11	Res., 1.5k, ± 5%, ¼W, Carbon	DRD139431
10R12	Res., 12k, ± 5%, ¼W, Carbon	DRD139601
10R13	Same as 10R12	
10R14	Res., 47, ±1%, ¼W, Metal	DRE939511
10R15	Res., 33, ±5%, ¼W, Carbon	DRD139911
10R21	Same as 10R15	
10R22	Same as 10R15	
10R23	Same as 10R14	
10R24	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
10R25	Res., 50k, Var., ½W, Carbon	DRV412061
10R26	Res., 100, ±5%, ¼ W,Carbon	DRD134591
10R31	Res., 33, ±1%, ¼W, Metal	DRE939491
10R32	Res., 10, ±5%, ¼W, Carbon	DRD139211
10R33	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
10R34	Same as 10R33	
10R35	Res., 270, ±5%, ¼W, Carbon	DRD139331
10R36	Same as 10R15	
10R37	Same as 10R35	
10R38	Same as 10R15	
10R41	Res., 680, ±1%, ¼W, Metal	DRE939631
10R42	Same as 10R41	
10R43	Same as 10R15	
10R44	Res., 220, ±1%, ¼W, Metal	DRE939601
10R45	Same as 10R44	
10R46	Res., 120, ±1%, ¼W, Metal	DRE939571
10R47	Same as 10R15	
10R48	Same as 10R15	
10R51	Same as 10R33	
10R52	Same as 10R33	
10R53	Res., 150,± 5%, ¼W, Carbon	DRD139101
10R54	Same as 10R15	
10R55	Same as 10R15	
10R61	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
10R62	Same as 10R61	
10R63	Res., 100, ±1%, ¼W, Metal	DRE939561
10R64	Same as 10R14	
10R71	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
10R72	Res., 220k, ±5%, ¼W, Carbon	DRD139321
10D41	Diode, 1S953	DDD010821
10D42	Same as 10D41	
10D55	Same as 10D41	
10D72	Diode, TLG206	DDD071121
10Q31	Transistor, 2SC2037	DTR137591
10Q35	Same as 10Q31	
10Q41	Transistor, 2SA1206	DTR119041
10Q45	Same as 10Q41	
10Q51	Transistor, 2SC1834	DTR131031
10Q55	Same as 10Q51	
10Q61	Same as 10Q31	
10Q62	Same as 10Q31	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
10IC1	IC, HA17458	DIC613511
10S1	Coupling switch, SUJ45A	DSW014901
10P1	Connector, M36-02-30-114P	DCN034851
10P2	Same as 10P1	
10P61	Same as 10P1	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
10J1	Connector, M36-M87-02	DCN034601
10J2	Connector, M36-M87-06	DCN034641
10J61	Connector, M36-M87-04	DCN034621

CIRCUIT REFERENCE	DECRIPTION	IWATSU PART NO.
B TRIGGER AMPLIFIER		
11C1	Cap., 1μ, +75%~ −10%, 50V, Elect.	DCE244711
11C2	Cap., 2200p, ±10%, 50V, Poly.	DCF129061
11C3	Cap., 47 μ, ±20%, 25V, Elect.	DCE229061
11C12	Cap., 0.1μ, ±10%, 50V, Poly.	DCF129601
11C15	Cap., 100p, ±5%, 50V, Cer.	DCC239051
11C23	Cap., 0.01μ, ±10%, 50V, Cer.	DCC133571
11C32	Cap., 56p, ±5%, 50V, Cer.	DCC239251
11C36	Cap., 0.01μ, ±10%, 50V, Cer.	DCC139501
11C38	Same as 11C36	
11C53	Same as 11C36	
11C55	Same as 11C36	
11C64	Same as 11C15	
11C65	Same as 11C3	
11C81	Same as 11C3	
11C82	Same as 11C36	
11C84	Same as 11C36	
11C85	Same as 11C3	
11C86	Same as 11C36	
11R3	Res., 22k, ±1%, ¼W, Metal	DRE939061
11R4	Res., 3.3k, ±1%, ¼W, Metal	DRE939661
11R5	Res., 18k, ±1%, ¼W, Metal	DRE939351
11R6	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
11R7	Res., 10k, ±1%, ¼W, Metal	DRE939301
11R8	Same as 11R7	
11R9	Res., 50k, Var., 0.2W, Carbon	DRV146811
11R11	Res., 1.5k, ±5%, ¼W, Carbon	DRD139431
11R12	Res., 39k, ±5%, ¼W, Carbon	DRD139701
11R13	Res., 12k, ± 5%, ¼W, Carbon	DRD139601
11R14	Res., 47, ±1%, ¼W, Metal	DRE939511
11R15	Res., 33, ±5%, ¼W, Carbon	DRD139911
11R21	Same as 11R15	
11R22	Same as 11R15	
11R23	Same as 11R14	
11R24	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
11R25	50k, Var., ½W, Cermet	DRV412061
11R26	Res., 100, ± 5%, ¼W, Carbon	DRD134591
11R31	Res., 33, ±1%, ¼W, Metal	DRE939491
11R32	Res., 10, ±5%, ¼W, Carbon	DRD139211
11R33	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
11R34	Same as 11R33	
11R35	Res., 270, ±5%, ¼W, Carbon	DRD139331
11R36	Same as 11R15	
11R37	Same as 11R35	
11R38	Same as 11R15	
11R41	Res., 680, ±1%, ¼W, Metal	DRE939631
11R42	Same as 11R41	
11R43	Same as 11R15	
11R44	Res., 220, ±1%, ¼W, Metal	DRE939601
11R45	Same as 11R44	
11R46	Res., 120, ±1%, ¼W, Metal	DRE939571
11R47	Same as 11R15	
11R48	Same as 11R15	
11R51	Same as 11R33	
11R52	Same as 11R33	
11R53	Res., 150, ± 5%, ¼W, Carbon	DRD139101
11R54	Same as 11R15	
11R55	Same as 11R15	
11R61	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
11R62	Same as 11R61	
11R63	Res., 100, ±1%, ¼W, Metal	DRE939561
11R64	Same as 11R14	
11D21	Diode, 1S953	DDD010821
11D41	Same as 11D21	
11D55	Same as 11D21	
11Q31	Transistor, 2SC1907	DTR137611
11Q35	Same as 11Q31	
11Q41	Transistor, 2SA1206	DTR119041
11Q45	Same as 11Q41	
11Q51	Transistor, 2SC1834	DTR131031
11Q55	Same as 11Q51	
11Q61	Transistor, 2SC2037	DTR137591
11Q65	Same as 11Q61	
11S1	Push switch, SUJ35A	DSW014881
11J1	Connector, M36-M87-02	DCN034601
11J2	Connector, M36-M87-04	DCN034621
11P1	Connector, M36-02-30-114P	DCN034851
11P2	Same as 11P1	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
TV SYNC SEPARATOR		
12C2	Cap., 47μ , ± 20%, 25V, Elect.	DCE229061
12C5	Cap., 0.01μ , +80%～ –20%, 50V, Cer.	DCC139501
12C7	Cap., 1μ , ±30%, 50V, Elect.	DCE244711
12C11	Cap., 470p,±5%, 50V, Cer.	DCC239151
12C12	Same as 12C2	
12C15	Cap., 1μ , ±20%, 50V, Elect.	DCE249121
12C31	Cap., 0.047 μ, ±10%, 50V, Elect.	DCF129581
12C32	Same as 12C5	
12C34	Same as 12C5	
12R2	Res., 6.8k, ±5%, ¼W, Carbon	DRD139561
12R3	Res., 2.7k,± 5%, ¼W, Carbon	DRD139481
12R4	Same as 12R2	
12R5	Res., 10k,±5%, ¼W, Carbon	DRD139161
12R6	Res., 150k, ±5%, ¼W, Carbon	DRD139771
12R7	Res., 2.2k, ±5%, ¼W, Carbon	DRD139461
12R11	Res., 82k, ±5%, ¼W, Carbon	DRD139741
12R12	Res., 680, ±5%, ¼W, Carbon	DRD139391
12R13	Res., 39k, ±5%, ¼W, Carbon	DRD139701
12R14	Res., 18k, ±5%, ¼W, Carbon	DRD139631
12R15	Res., 7.5k, ±5%, ¼W, Carbon	DRD139571
12R16	Res., 12k, ±5%, ¼W, Carbon	DRD139601
12R17	Same as 12R6	
12R18	Same as 12R5	
12R21	Same as 12R5	
12R25	Same as 12R2	
12R31	Res.. 470k, ± 5%, ¼W, Carbon	DRD139371
12R32	Res., 1k, ±5%, ¼W, Carbon	DRD139141
12R33	Same as 12R5	
12R34	Same as 12R5	
12R41	Res., 8.2k, ±5%, ¼W, Carbon	DRD139581
12R42	Same as 12R41	
12R43	Same as 12R7	
12D2	Diode, 1S953	DDD010821
12D12	Diode, RD4.7EB1	DDD033131
12D31	Same as 12D2	
12D41	Same as 12D2	
12D42	Same as 12D2	
12Q1	Transistor, 2SA1015Y	DTR119011
12Q5	Same as 12Q1	
12Q11	Same as 12Q1	
12Q15	Transistor, 2S1815GR	DTR139011
12Q21	Same as 12Q15	
12Q25	Same as 12Q15	
12Q41	Same as 12Q1	
12IC31	IC, SN74LS08N	DIC140091
12IC35	IC, SN74LS02N	DIC140031

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
A SWEEP GENERATOR		
13C1	Cap., 0.01μ, +80% ~−20%, 50V, Cer.	DCC139501
13C5	Same as 13C1	
13C7	Cap., 120p, ±5%, 50V, Cer.	DCC239261
13C11	Cap., 47μ, ±20%, 25V, Elect.	DCE229061
13C12	Cap., 22p, ± 5%, 50V, Cer.	DCC239121
13C15	Cap., 220p, ±5%, 50V, Cer.	DCC239181
13C18	Same as 13C7	
13C19	Cap., 4.7μ, ±20%, 50V, Elect.	DCE249151
13C21	Same as 13C15	
13C22	Same as 13C12	
13C25	Same as 13C11	
13C26	Same as 13C15	
13C27	Same as 13C1	
13C28	Same as 13C1	
13C31	Cap., 33p, ±5%, 50V, Cer.	DCC239011
13C32	Same as 13C31	
13C33	Cap., 1000p, ±10%, 50V, Poly.	DCF129071
13C34	Same as 13C1	
13C35	Same as 13C11	
13C36	Same as 13C1	
13C41	Cap., 10p, ±0.5%, 50V, Cer.	DCC239041
13C42	Cap., 68p, ±5%, 100V, Cer.	DCC249531
13C43	Cap., 2.5~22.5p, Var., 250V, Cer.	DCV019641
13C44	Cap., 56p, ± 5%, 50V, Cer.	DCC239251
13C45	Same as 13C1	
13C46	Same as 13C44	
13C61	Same as 13C31	
13C65	Same as 13C41	
13C71	Same as 13C12	
13C72	Same as 13C7	
13C73	Same as 13C15	
13C75	Same as 13C19	
13C78	Same as 13C1	
13C81	Same as 13C1	
13C82	Same as 13C1	
13C94	Same as 13C34	
13C96	Same as 13C34	
13C98	Same as 13C1	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
13R1	Res., 2.2k, ±5%, ¼W, Carbon	DRD139461
13R2	Res., 3.9k, ±5%, ¼W, Carbon	DRD139531
13R3	Res., 150, ±1%, ¼W, Metal	DRE130631
13R4	Res., 1k, ± 5%, ¼W, Carbon	DRD139141
13R5	Res., 470, ±5%, ¼W, Carbon	DRD139371
13R6	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
13R7	Res., 5.6k, ± 5%, ¼W, Carbon	DRD139541
13R8	Same as 13R1	
13R9	Same as 13R1	
13R10	Same as 13R4	
13R11	Res., 3.3k, ± 5%, ¼W, Carbon	DRD139501
13R12	Same as 13R1	
13R13	Same as 13R4	
13R14	Res., 5.6k, ±1%, ¼W, Metal	DRE939671
13R15	Res., 820, ±1%, ¼W, Metal	DRE939151
13R16	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
13R17	Res., 4.7k, ± 5%, ¼W, Carbon	DRD139151
13R18	Res., 18k, ± 5%, ¼W, Carbon	DRD135131
13R19	Res., 100k, ± 5%, ¼W, Carbon	DRD135311
13R20	Res., 1.2k, ± 5%, ¼W, Carbon	DRD139661
13R21	Same as 13R7	
13R22	Same as 13R17	
13R25	Same as 13R1	
13R26	Same as 13R5	
13R28	Same as 13R7	
13R32	Same as 13R4	
13R33	Same as 13R7	
13R34	Res., 2.7k, ± 5%, ¼W, Carbon	DRD139481
13R35	Res., 100, ± 5%, ¼W, Carbon	DRD139291
13R43	Res., 680, ±5%, ¼W, Carbon	DRD139391
13R44	Res., 1k, ± 1%, ¼W, Metal	DRE939071
13R45	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
13R46	Res., 1.5k, ±1%, ¼W, Metal	DRE939641
13R47	Res., 330k, ± 1%, ¼W, Metal	DRE939621
13R51	Same as 13R34	
13R52	Same as 13R4	
13R53	Same as 13R45	
13R54	Same as 13R35	
13R55	Same as 13R18	
13R56	Same as 13R35	
13R61	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
13R62	Same as 13R61	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
13R63	Res., 10k, ±1%, ¼W, Metal	DRE939301
13R64	Same as 13R15	
13R65	Res., 4.7k, ±1%, ¼W, Metal	DRE939471
13R66	Res., 27k, ±1%, ¼W , Metal	DRE939361
13R67	Same as 13R4	
13R68	Same as 13R17	
13R71	Same as 13R7	
13R72	Same as 13R6	
13R73	Res., 560, ±5%, ¼W, Carbon	DRD139121
13R74	Same as 13R73	
13R75	Res., 1.5k, ± 5%, ¼W, Carbon	DRD139431
13R76	Same as 13R18	
13R77	Same as 13R34	
13R78	Same as 13R18	
13R81	Res., 8.5k, ± 5%, ¼W, Carbon	DRD139581
13R82	Same as 13R7	
13R83	Res., 1.8k, ±5%, ¼W, Carbon	DRD139441
13R84	Same as 13R34	
13R85	Same as 13R6	
13R86	Res., 100k, Var., 1/8W, Carbon	DRV146831
13R87	Same as 13R6	
13R88	Same as 13R6	
13R91	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
13R92	Same as 13R91	
13R93	Same as 13R91	
13R94	Same as 13R91	
13R95	Res., 820, ± 5%, ¼W, Carbon	DRD139941
13R96	Same as 13R1	
13R97	Same as 13R35	
13R98	Same as 13R34	
13R99	Same as 13R2	
13R101	Same as 13R35	
13D5	Diode, 1S953	DDD010821
13D12	Same as 13D5	
13D15	Same as 13D5	
13D19	Same as 13D5	
13D25	Same as 13D5	
13D26	Same as 13D5	
13D27	Same as 13D5	
13D28	Same as 13D5	
13D31	Same as 13D5	
13D43	Diode, RD 10FB	DDD032251
13D44	Same as 13D43	
13D55	Diode, RD 5.6E	DDD031141
13D75	Same as 13D5	
13Q15	Transistor, 2SC1834	DTR131031
13Q21	Transistor, 2SA1015Y	DTR119011
13Q25	Same as 13Q15	
13Q31	Transistor, 2SC1254	DTR130861
13Q35	Same as 13Q15	
13Q37	Same as 13Q15	
13Q41	FET. 2SD30A-Y	DTR210141
13Q43	Transistor, 2SC1834	DTR131031
13Q51	Transistor, 2SC1815GR	DTR139011
13Q55	Same as 13Q51	
13Q61	Same as 13Q21	
13Q63	Same as 13Q21	
13Q65	Same as 13Q15	
13Q71	Same as 13Q51	
13Q87	Same as 13Q51	
13Q98	Same as 13Q51	
13IC1	IC, F10107DC	DIC310051
131C5	IC, F10131DC	DIC310081
13IC11	IC, SN74LS123N	DIC141181
13IC15	IC, SN74LS08N	DIC140091
13IC21	IC, SN74LS00N	DIC140011
13IC26	IC, SN74LS02N	DIC140031
13IC71	IC, SN74LS74AN	DIC140751
13IC75	IC, CD4066BE	DIC410591
13IC81	IC, μPC272C	DIC630741
13IC91	Same as 13IC71	
13J1	Connector, BNC	DCN034621
13J25	Connector, BNC	DCN034601
13J26	Connector, BNC	DCN040711
13J91	Connector, BNC	DCN030691
13P1	Connector, BNC	DCN034871
13P5	Connector, BNC	DNC034851
13P25	Same as 13P5	
13P95	Same as 13P5	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
B SWEEP GENERATOR		
14C1	Cap., 47 μ, ±20%, 25V, Elect.	DCE229061
14C2	Cap., 0.01 μ, +80% ~–20%, 50V, Cer.	DCC139501
14C3	Same as 14C1	
14C4	Same as 14C2	
14C5	Same as 14C2	
14C6	Same as 14C2	
14C7	Same as 14C2	
14C8	Same as 14C2	
14C11	Same as 14C2	
14C12	Same as 14C1	
14C13	Cap., 330p, ±5%, 50V, Cer.	DCC239181
14C14	Same as 14C2	
14C15	Cap., 22p, ±5%, 50V, Cer.	DCC239121
14C16	Same as 14C2	
14C17	Same as 14C1	
14C18	Same as 14C2	
14C19	Same as 14C1	
14C22	Same as 14C15	
14C26	Same as 14C13	
14C31	Cap., 33p, ±5%, 50V, Cer.	DCC239011
14C32	Same as 14C31	
14C33	Cap., 1000p, ±10%, 50V, Poly	DCF129071
14C35	Same as 14C1	
14C36	Same as 14C2	
14C41	Cap., 10p, ±0.5p, 50V, Cer.	DCC239041
14C42	Cap., 56p, ±5%, 100V, Cer.	DCC249521
14C43	Cap., 2.5 ~2.5p, Var., 250V, Cer.	DCV019531
14C44	Cap., 56p, ±5%, 50V, Cer.	DCC239251
14C46	Same as 14C44	
14C55	Cap., 1 μ, ± 20%, 50V, Elect.	DCE249121
14C61	Same as 14C15	
14C63	Cap., 100p, ± 5%, 50V, Cer.	DCC239051
14C64	Same as 14C1	
14C75	Same as 14C2	
14C83	Same as 14C44	
14C98	Same as 14C2	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
14R1	Res., 3.9k, ± 5%, ¼W, Carbon	DRD139521
14R2	Res., 2.2k, ± 5%, ¼W, Carbon	DRD139461
14R3	Res., 270, ±1%, ¼W, Metal	DRE939611
14R4	Res., 1k, ± 5%, ¼W, Carbon	DRD139141
14R5	Same as 14R4	
14R6	Same as 14R2	
14R7	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
14R8	Res., 680, ±1%, ¼W, Metal	DRE939631
14R9	Res., 1.8k, ±1%, ¼W, Metal	DRE939171
14R10	Same as 14R4	
14R11	Same as 14R2	
14R12	Same as 14R2	
14R13	Res., 820, ±1%, ¼W, Metal	DRE939151
14R14	Res., 5.8k, ±1%, ¼W, Metal	DRE939671
14R15	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
14R16	Res., 27k, ±5%, ¼W, Carbon	DRD139661
14R17	Res., 3.3k, ±5%, ¼W, Carbon	DRD139501
14R18	Same as 14R4	
14R22	Res., 4.7k, ±5%, ¼W, Carbon	DRD139151
14R25	Same as 14R2	
14R26	Res., 470, ±5%, ¼W, Carbon	DRD139371
14R28	Res., 5.6k, ±5%, ¼W, Carbon	DRD139541
14R32	Same as 14R4	
14R33	Same as 14R28	
14R34	Res., 2.7k, ±5%, ¼W, Carbon	DRD139481
14R35	Res., 100, ±5%, ¼W, Carbon	DRD139291
14R36	Same as 14R26	
14R43	Res., 680, ±5%, ¼W, Carbon.	DRD139391
14R44	Res., 1k, ±1%, ¼W, Metal	DRE939071
14R45	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
14R46	Res., 1.5k, ±1%, ¼W, Metal	DRE939641
14R47	Res., 330, ±1%, ¼W, Metal	DRE939621
14R48	Res., 10k, ±5%, ¼W, Carbon	DRD139161
14R51	Same as 14R35	
14R52	Same as 14R4	
14R53	Same as 14R45	
14R55	Res., 22k, ±5%, ¼W, Carbon	DRD139641
14R56	Same as 14R35	
14R61	Same as 14R45	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
14R62	Res., 4.7I, ±1%, ¼W, Metal	DRE939471
14R63	Res., 180 k, ±1%, ¼W, Metal	DRE939711
14R64	Same as 14R22	
14R65	Same as 14R2	
14R66	Same as 14R2	
14R67	Same as 14R7	
14R68	Same as 14R1	
14R69	Same as 14R2	
14R71	Same as 14R56	
14R72	Same as 14R56	
14R73	Same as 14R44	
14R74	Res., 8.2k, ±1%, ¼W, Metal	DCE939051
14R75	Res., 2.7k, ±1%, ¼W, Metal	DCE939651
14R76	Res., 12k, ±1%, ¼W, Metal	DCE939681
14R77	Same as 14R56	
14R81	Res., 27k, ±1%, ¼W, Metal	DCE939361
14R82	Same as 14R13	
14R83	Same as 14R76	
14R84	Same as 14R81	
14R85	Same as 14R1	
14R86	Same as 14R17	
14R91	Same as 14R74 Cermet	
14R92	Res., 1k, Var., 0.3W, Cermet	DRV412031
14R93	Same as 14R75	
14R94	Same as 14R34	
14R95	Res., 10k, Var., 1.5W, W.W.	DRV770351
14R96	Same as 14R92	
14R97	Same as 14R34	
14R98	Same as 14R4	
14R99	Res., 560, ±1%, ¼W, Metal	DRE939141

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
14D9	Diode, 1S953	DDD018
14D15	Same as 14D9	
14D25	Same as 14D9	
14D26	Same as 14D9	
14D27	Same as 14D9	
14D28	Same as 14D9	
14D31	Same as 14D9	
14D43	Z. Diode, RD10FB	DDD032251
14D44	Same as 14D43	
14D55	Z.Diode, RD6.6ED1	DDD031141
14D61	Same as 14D9	
14D62	Same as 14D9	
14Q15	Transistor, 2SC1834	DTR131031
14Q25	Same as 14Q15	
14Q31	Transistor, 2SC1254	DTR130861
14Q35	Same as 14Q15	
14Q37	Same as 14Q15	
14Q41	FET, 2SK30A-Y	DTR210141
14Q43	Same as 14Q15	
14Q45	Transistor, 2SA1015Y	DTR119011
14Q51	Transistor, 2SC1815GR	DTR139011
14Q55	Same as 14Q51	
14Q81	Same as 14Q45	
14Q83	Same as 14Q45	
14IC1	IC, F10107DC	DIC310051
14IC5	IC, F10131DC	DIC310081
14IC11	IC, F10116DC	DIC310201
14IC71	IC, CA3086	DIC190381
14IC91	IC, HA17458	DIC613511
14J1	Connector, FF-10-002	DCN030711
14J21	Connector, M36-M87-02	DCN034601
14J25	Same as 14J21	
14J26	Connector, BNC	DCN040711
14J41	Connector, M36-M87-03	DCN034611
14J91	Same as 14J41	
14P5	Connector, M36-02-30- 114P	DCN034851
14P21	Same as 14P5	
14P25	Same as 14P5	
14P41	Connector, M36-03-30-114P	DCN034861
14P91	Same as 14P41	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
TIMING SWITCHES		
15C23	Cap., 0.01μ, +80% ~ −20%, 50V, Cer.	DCC139501
15C31	Cap., 1μ, ±1%, 50V, Poly.	DCF420281
15C32	Cap., 0.1μ, ±1%, 50V, Poly.	DCF420271
15C33	Cap., 9900P, ± 0.25%, 50V, Poly.	DCF125791
15C34	Cap., 900P, ± 0.25%, 50V, Poly.	DCF125801
15C35	Cap., 56p, ± 5%, 50V, Cer.	DCC239251
15C41	Cap., 1μ, ± 20%, 50V, Elect.	DCE249121
15C42	Cap., 0.1μ, ±10%, 50V, Poly.	DCF129601
15C43	Cap., 6800P, ± 10%, 50V, Poly.	DCF129201
15C71	Same as 15C23	
15C73	Same as 15C23	
15C82	Same as 15C32	
15C83	Same as 15C33	
15C84	Same as 15C34	
15C85	Same as 15C35	
15R1	Res., 7.5M, ±1%, ½W, Metal	DRE560141
15R3	Res., 2.5M, ±1%, ½W, Metal	DRE560131
15R6	Res., 1.25M, ±1%, ½W, Metal	DRE560121
15R7	Res., 750k, ±0.5%, 1/8W, Metal	DRE249121
15R8	Res., 250k, ±0.5%, ½W, Metal	DRE249111
15R9	Same as 15R8	
15R11	Res., 126.2k, ±0.5%, 1/8W, Metal	DRE229141
15R12	Res., 55.6k, ± 0.5%, 1/8W, Metal	DRE229131
15R13	Res., 25k, ± 0.5%, 1/8W, Metal	DRE229121
15R14	Res., 12.5k, ± 0.5%, 1/8W, Metal	DRE229111
15R15	Res., 5k, ± 0.5%, ¼W, Metal	DRE239121
15R21	Res., 8.2k, ±1%, ¼W, Metal	DRE939051
15R22	Res., 3.9k, ± 1%, ¼W, Metal	DRE939421
15R23	Res., 50k, Var., 0.1W, Carbon	DRV147401
15R24	Same as 15R21	
15R25	Same as 15R22	
15R26	Res., 3.9k, ± 5%, ¼W, Carbon	DRD139521
15R31	Res., 47, ± 5%, ¼W, Carbon	DRD139261
15R32	Res., 220, ± 5%, ¼W, Carbon	DRD139321
15R41	Res,. 22k, ± 5%, ¼W, Carbon	DRD139641
15R51	Same as 15R1	
15R53	Same as 15R3	
15R56	Same as 15R6	
15R57	Same as 15R7	
15R58	Same as 15R8	
15R59	Same as 15R8	
15R61	Same as 15R11	
15R62	Same as 15R12	
15R63	Same as 15R13	
15R64	Same as 15R14	
15R65	Same as 15R15	
15R71	Same as 15R21	
15R72	Res., 22k, ± 1%, ¼W, Metal	DRE939061
15R73	Res., 5k, Var., 0.3W, Cermet	DRV412091
15R74	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
15R81	Same as 15R31	
15R82	Same as 15R32	
15D26	L.E. D, TLR206	DDD070181
15Q21	Transistor, 2SA578	DTR110331
15Q23	Transistor, 2SC1815GR	DTR139011
15Q71	Same as 15Q21	
15Q73	Same as 15Q23	
15S1	Rotary switch,	DSW034632
15J81	Connector, M36-M87-03	DCN034611
15P81	Connector, M36-03-30-114P	DCN034861

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
HORIZONTAL SWITCHES		
16D1	Diode, 1S953	DDD010821
16D2	L.E.D., TLR206	DDD070181
16S1	Push switch, SUJ50A	DSW014911
16S2	Push switch, SUJ30A	DSW014871
16J1	Connector, FF-12-002	DCN030701

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
HORIZONTAL CONTROL		
17C1	Cap., 0.01μ, +80%～−20%, 50V, Cer.	DCC139501
17C3	Same as 17C1	
17C6	Cap., 0.1 μ, +80%～−20%, 50V, Cer.	DCC939011
17C9	Cap., 47 μ, ±20%, 25V, Elect.	DCE229061
17C14	Cap., 0.001 μ, +80% ～−20%, 50V, Poly.	DCF129071
17C15	Same as 17C1	
17C16	Cap., 270p, ±5%, 50V, Cer.	DCC239281
17C24	Same as 17C1	
17C33	Same as 17C1	
17C41	Same as 17C1	
17C43	Cap., 100p, ± 5%, 50V, Cer.	DCC239051
17C44	Same as 17C1	
17C45	Same as 17C1	
17C48	Same as 17C1	
17C51	Cap., 330p, ±5%, 50V, Cer.	DCC239181
17C52	Cap., 22p, ±5%, 50V, Cer.	DCC239121
17C81	Cap., 1 μ, ±20%, 50V, Elect.	DCE249121
17C82	Same as 17C81	
17C83	Same as 17C1	
17C84	Same as 17C1	
17C85	Same as 17C9	
17C86	Same as 17C9	
17C87	Same as 17C1	
17C88	Same as 17C1	
17C91	Same as 17C9	
17C92	Same as 17C1	
17C95	Same as 17C1	
17R1.2	Res., (10k, 50k,) Var., 1/8W, Carbon	DRV146841
(17S2)	With switch	
17R3	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
17R4	Res., 68k, ±5%, ¼W, Carbon	DRD139731
17R6	Res., 4.7k, ± 5%, ¼W, Carbon	DRD139151
17R7	Res., 50k, Var., 1/8W, Carbon	DRV146821
17R8	Res., 10k, ±5%, ¼W, Carbon	DRD139161
17R9	Res., 1k, ±5%, ¼W, Carbon	DRD139141
17R11	Res., 5k, 0.3W, Carbon	DRV412091
17R12	Res., 36k, ±1%, ¼W, Metal	DRE939691
17R13	Same as 17R12	
17R14	Res., 2.2k, ± 5%, ¼W, Carbon	DRD139461
17R15	Same as 17R3	
17R16	Res., 820, ±1%, ¼W, Metal	DRE939151
17R17	Res., 15k, ±1%, ¼W, Metal	DRE939341
17R21	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
17R22	Res., 33k, ±5%, ¼W, Carbon	DRD139681
17R23	Same as 17R21	
17R31	Same as 17R8	
17R32	Same as 17R8	
17R33	Same as 17R8	
17R41	Res., 12k, ±5%, ¼W, Carbon	DRD139601
17R42	Res., 15k, ±5%, ¼W, Carbon	DRD139611
17R43	Same as 17R3	
17R44	Res., 4.7k, ±1%, ¼W, Metal	DRE939471
17R45	Res., 220, ±1%, ¼W, Metal	DRE939601
17R46	Res., 3.3k, ±5%, ¼W, Carbon	DRD139501
17R47	Same as 17R8	
17R51	Res., 560, ±5%, ¼W, Carbon	DRD139121
17R52	Same as 17R51	
17R91	Same as 17R8	
17R95	Same as 17R8	
17D11	Diode, 1S953	DDD010821
17D12	Same as 17D11	
17D13	Same as 17D11	
17D14	Same as 17D11	
17D15	Same as 17D11	
17D16	Same as 17D11	
17D21	Diode, 1SS16	DDD010411
17D22	Same as 17D21	
17D23	Same as 17D21	
17D24	Same as 17D11	
17D25	Same as 17D11	
17D26	Same as 17D11	
17D27	Same as 17D11	
17D28	Same as 17D11	
17D29	Same as 17D11	
17D31	Same as 17D11	
17D41	Same as 17D11	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
17D42	Same as 17D11	
17D47	Same as 17D11	
17D48	Same as 17D11	
17Q1	Transistor, 2SC1815GR	DTR139011
17Q11	Same as 17Q1	
17Q15	Transistor, 2SA1015Y	DTR119011
17Q41	Same as 17Q1	
17Q45	Same as 17Q1	
17Q47	Same as 17Q15	
17IC1	IC, SN74LS00N	DIC140011
17IC31	IC, SN74LS74AN	DIC140751
17IC51	Same as 17IC1	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
17J1	Connector, M36-M87-06	DCN034641
17J21	Connector, M36-M87-05	DCN034631
17J25	Connector, M36-M87-02	DCN034601
17J31	Connector, FF-10-001	DCN030681
17J81	Connector, M31-M87-10	DCN034531
17P1	Connector, M36-06-30-114P	DCN034891
17P21	Connector, M36-05-30-114P	DCN034881
17P25	Connector, M36-02-30-114P	DCN034851
17P81	Connector, M36-10-30-114P	DCN034721
17P91	Connector, M36-04-30-114P	DCN034871

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
HORIZONTAL AMPLIFIER		
18C11	Cap., 0.047μ, ±20%, 250V, Poly.	DCF160291
18C12	Cap., 0.01μ, +80% ~ –20%, 50V, Cer.	DCC139501
18C13	Cap., 22μ, 20%, 25V, Elect.	DCE229041
18C14	Same as 18C12	
18C15	Same as 18C13	
18C16	Same as 18C12	
18C17	Cap., 0.1 μ +80% ~ –20%, 50V, Cer.	DCC939011
18C18	Same as 18C13	
18C19	Same as 18C12	
18C31	Same as 18C12	
18C51	Cap., 33p, ±5%, 50V, Cer.	DCC239011
18C58	Cap., 27p, ±0.25p, 500V, Cer.	DCC239241
18C62	Same as 18C12	
18C65	Cap., 82p, ± 5%, 50V, Cer.	DCC239141
18C66	Cap., 0.01μ, ±10%, 200V, Poly.	DCF159501
18C72	Cap., 0.1μ, ± 20%, 250V, Poly.	DCF158021
18C75	Cap., 2~ 8p, Var., 250V, Cer.	DCV019561
18C76	Cap., 1p, ± 0.25p, 500V, Cer.	DCC259101
18C81	Cap., 270p, ±5%, 50V, Cer.	DCC239281
18C82	Same as 1866	
18C83	Same as 18C12	
18C91	Same as 18C72	
18C94	Same as 18C75	
18C95	Same as 18C76	
18R11	Res.,47, ± 5%, ¼W, Carbon	DCD139261
18R12	Res., 3.3k, ± 5%, ¼W, Carbon	DCD139501
18R13	Res., 1.8k, ±1%, ¼W, Metal	DRE939651
18R14	Res., 3.3k, ±1%, ¼W, Metal	DRE939661
18R15	Res., 1.2k, ±1%, ¼W, Metal	DRE939291
18R16	Res., 8.2k, ±1%, ¼W, Metal	DRE939051
18R17	Same as 18R16	
18R21	Same as 18R15	
18R22	Same as 18R16	
18R23	Same as 18R16	
18R24	Res., 270, ±1%, ¼W, Metal	DRE939611
18R25	Same as 18R24	
18R26	Res., 820, ±5%, ¼W, Carbon	DRD139941
18R27	Same as 18R26	
18R31	Res., 100, Var., 0.3W, Cermet.	DRV412001
18R32	Res., 1k, ±15%, Thermistor,	DDD080421
18R33	Res., 56, ±1%, ¼W, Metal	DRE939521
18R34	Res., 390, ± 5%, ¼W, Carbon	DRD139361
18R35	Res., 1k, ± 1%, ¼W, Metal	DRE939071
18R36	Res., 5k, Var., 0.3W, Cermet	DRV412051
18R41	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
18R42	Res., 18k, ±1%, ¼W, Metal	DRE939351
18R43	Res., 27k, ± 1%, ¼W, Metal	DRE939361
18R44	Res., 220k, ± 5%, ¼W, Carbon	DRD139791
18R45	Same as 18R42	
18R46	Res., 22k, ±1%, ¼W, Metal	DRE939061
18R51	Res., 270, ± 5%, ¼W, Carbon	DRD139331
18R52	Res., 680, ±1%, ¼W, Metal	DRE939631
18R53	Same as 18R52	
18R54	Res., 820, ±1%, ¼W, Metal	DRE939151
18R55	Res., 4.7 k, ± 1%, ¼W, Metal	DRE939471
18R56	Res., 500, Var., 0.3W, Cermet	DRV412021
18R57	Same as 18R55	
18R58	Same as 18R51	
18R59	Same as 18R56	
18R61	Res., 1.8k, ±5%, ¼W, Carbon	DRD139441
18R62	Same as 18R61	
18R63	Res., 5.6k, ±1%, ¼W, Metal	DRE939671
18R64	Res., 100k, ±1%, ¼W, Metal	DRE939191
18R65	Res., 120, ± 5%, ¼W, Carbon	DRD139301
18R66	Same as 18R61	
18R71	Same as 18R54	
18R72	Res., 27k, ± 5%, ¼W, Carbon	DRD139661
18R73	Res., 22k, ±5%, ¼W, Carbon	DRD139641
18R74	Same as 18R11	
18R75	Res., 22k, ±1%, ¼W, Metal	DRE939061
18R76	Same as 18R75	
18R81	Same as 18R65	
18R82	Res., 2.7k, ± 5%, ¼W, Carbon	DRD139481
18R83	Same as 18R64	
18R84	Same as 18R63	
18R91	Same as 18R54	
18R92	Same as 18R72	
18R93	Same as 18R73	
18R94	Same as 18R11	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
18R95	Same as 18R75	
18R96	Same as 18R75	
18R101	Same as 18R26	
18R102	Res., 50k, Var., 0.3W, Cermet	DRV412061
18RL31	Reed Relay, HA-112H	DKD062041
18D25	Diode, RD10FB	DDD032251
18Q11	Transistor, 2SC1815GR	DTR139011
18Q12	Same as 18Q11	
18Q13	Transistor, 2SA1206	DTR119041
18Q14	Same as 18Q13	
18Q15	Transistor, 2SA1015Y	DTR119011
18Q16	Same as 18Q11	
18Q21	Same as 18Q11	
18Q22	Same as 18Q11	
18Q23	Same as 18Q13	
18Q24	Transistor, 2SC1907	DTR137611
18Q25	Transistor, 2SA899G/B	DTR115691
18Q26	Transistor, 2SC1904G/B	DTR137051
18Q31	Same as 18Q24	
18Q32	Same as 18Q25	
18Q33	Same as 18Q26	
18Q101	Same as 18Q21	
18Q102	Same as 18Q15	
18J11	Connector, M36-M87-06	DCN034641
18J12	Same as 18J11	
18P11	Connector, M36-06-30-134P	DCN034946
18P12	Same as 18P11	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
Z AXIS CIRCUIT		
19C13	Cap., 0.01μ, +80%～−20%, 50V, Cer.	DCC139501
19C16	Same as 19C13	
19C17	Cap., 1μ, ±20%, 25V, Elect.	DCE249121
19C24	Same as 19C16	
19C25	Same as 19C16	
19C26	Cap., 0.1 μ, ±2%, 50V, Poly.	DCF129601
19C27	Same as 19C17	
19C31	Cap., 22 μ, ±20%, 25V, Elect.	DCE229041
19C34	Same as 19C16	
19C41	Same as 19C16	
19C42	Cap., 10p,± 0.5%, 50V, Cer.	DCC239041
19C43	Cap., 0.047 μ, ±20%, 250V, Poly.	DCF160291
19C44	Same as 19C16	
19C45	Same as 19C16	
19C46	Cap., 12p,～ 0.25p, 500V, Cer.	DCC259111
19C47	Cap., 2～8p, Var., 250V, Cer.	DCV019561
19C51	Cap., 0.1μ, 20%, 250V, Poly.	DCF158021
19C52	Same as 19C51	
19C57	Cap., 1p, ±0.25p, 50V, Cer.	DCC239191
19C61	Same as 19C42	
19C63	Same as 19C51	
19C64	Cap., 0.047 μ, ±20%, 630V, Poly.	DCF171131
19C68	Cap., 0.01μ, ±20%, 630V, Poly.	DCF170201
19R11	Res., 2.7k, ±5%, ¼W, Carbon	DRD139481
19R12	Same as 19R11	
19R13	Res., 33k, ±5%, ¼W, Carbon	DRD139681
19R14	Res., 10, ±5%, ¼W, Carbon	DRD139211
19R15	Res., 2.2k, ±1%, ¼W, Metal	DRE939021
19R16	Res., 47k, ±5%, ¼W, Carbon	DRD139171
19R17	Same as 19R16	
19R18	Res., 12k, ±5%, ¼W, Carbon	DRD139601
19R19	Res., 100k, ±5%, ¼W, Carbon	DRD139751
19R20	Res., (50k, 50k), Var., 0.1W, Carbon with switch	DRV147391
19R21	Res., 4.7k, ±5%, ¼W, Carbon	DRD139151
19R22	Res., 820, ±5%, ¼W, Carbon	DRD139941
19R23	Res., 1k, ±5%, ¼W, Carbon	DRD139141
19R24	Same as 19R23	
19R25	Res., 10k, ± 5%, ¼W, Carbon	DRD139161
19R26	Res., 100, ±5%, ¼W, Carbon	DRD139291
19R27	Same as 19R25	
19R28	Res., 47k, 5%, ¼W, Carbon	DRD135231
19R31	Res., 500, Var., 0.3W, Cer.	DRV412021
19R32	Res., 560, ± 5%, ¼W, Carbon	DRD139121
19R33	Res., 1k, ±1%, ¼W, Metal	DRE939071
19R34	Same as 19R33	
19R35	Res., 15k, ±1%, ¼W, Metal	DRE939341
19R36	Res., 1.8k, ± 1%, ¼W, Metal	DRE939171
19R41	Res., 22k, ± 5%, ¼W, Carbon	DRD139641
19R42	Same as 19R23	
19R43	Same as 19R22	
19R44	Same as 19R23	
19R45	Res., 82k, ± 5%, ¼W, Carbon	DRD139741
19R46	Res., 8.2k, ± 5%, ¼W, Carbon	DRD139581
19R47	Same as 19R22	
19R50	Same as 19R21	
19R51	Res., 3.9k, ± 5%, ¼W, Carbon	DRD139521
19R52	Same as 19R51	
19R53	Same as 19R51	
19R54	Res., 300 , ± 5%, ¼W, Carbon	DRD139341
19R55	Same as 19R46	
19R57	Same as 19R46	
19R61	Res., 5.6k, ± 5%, ¼W, Carbon	DRD139541
19R62	Res., 50k, Var., 0.5W, Cermet	DRV420221
19R63	Res., 39k, ± 5%, ¼W, Carbon	DRD139701
19R64	Same as 19R63	
19R65	Same as 19R25	
19R66	Same as 19R25	
19R67	Res., 180k, ±1%, ¼W, Metal	DRE949041
19R68	Res., 150k, ±1%, ¼W, Metal	DRE949021
19R69	Res., 220k, ± 1%, ¼W, Metal	DRE949031
19R70	Res., 100k, ± 1%, ¼W, Metal	DRE939191
19R71	Res., 100k, Var., 0.5W, Cermet	DRV411111
19D17	Diode, 1S953/TA21R	DDD010821
19D21	Same as 19D17	
19D22	L.E D, TLR206	DDD070181
19D31	Same as 19D17	
19D32	Diode, 1SS16	DDD010411
19D33	Same as 19D17	
19D41	Diode, ERB26-20	DDD023571
19D61	Same as 19D17	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
19Q11	Transistor, 2SC1815GR	DTR139011
19Q12	Same as 19Q11	
19Q13	Same as 19Q11	
19Q14	Transistor, 2SA1015Y	DTR119011
19Q15	Same as 19Q11	
19Q16	Transistor, 2SA899G/B	DTR115691
19Q17	Transistor, 2SC1904G/B	DTR137051
19Q18	Same as 19Q17	
19IC1	IC, SN74LS08N	DIC140091
19IC2	IC, SN74LS74AN	DIC140751

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
19J1	BNC Connector, BNC080	DCN040711
19J11	Connector, M36-M87-04	DCN034621
19P11	Connector, M36-04-30-114P	DCN034871

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
CRT CIRCUIT		
20C1	Cap., 47 μ, ±20%, 100V, Elect.	DCE255091
20C2	Cap., 100p, ±10%, 500V, Cer.	DCC259141
20C3	Cap., 0.047 μ, ±20%, 600V, Poly.	DCF171131
20C5	Cap., 0.01 μ, +80% ~ −20%, 3kV, Cer.	DCC173501
20C6	Cap., 1000p, ±20%, 3kV, Cer.	DCC171831
20C7	Same as 20C5	
20C11	Cap., 0.01 μ, ± 20%, 3kV, Cer.	DCC173501
20C15	Cap., 0.22 μ, ±10%, 50V, Poly.	DCF129711
20C18	Cap., 56p, ± 5%, 50V, Cer.	DCC239251
20C23	Cap., 0.1μ , ±10%, 50V, Poly.	DCF129601
20C24	Cap., 0.015 μ, ±10%, 50V, Poly.	DCF129031
20C27	Cap., 1μ , +75% ~ −10%, 50V, Elect.	DCE244711
20C31	Cap., 0.01 μ, +80% ~ −20%, 50V, Cer.	DCC139501
20C33	Cap., 22 μ, ±20%, 25V, Elect.	DCE229041
20C37	Cap., 4.7 μ, ±20%, 50V, Elect.	DCE249151
20C41	Same as 20C11	
20C42	Same as 20C6	
20C43	Same as 20C11	
20C44	Cap., 1 μ, +75% ~ −10%, 250V, Elect.	DCE270251
20C54	Cap., 0.01μ , +80% ~ −20%, 50V, Cer.	DCC163511
20C55	Same as 20C54	
20C57	Same as 20C54	
20C61	Same as 20C54	
20C70	Cap., 0.01 μ, +80% ~ −20%, 50V, Cer.	DCC133571
20L61	Inductor, Lotation Coil	DCL140111
20L62	Inductor, Orthogonality Coil	DCL140251
20R1	Res., 330, ±5%, ¼W, Carbon	DRD139351
20R2	Res., 220k, ±5%, ¼W, Carbon	DRD139791
20R3	Res., 100k, ± 5%, ¼W, Carbon	DRD139751
20R4	Same as 20R2	
20R10	Res., 100k, ± 5%, ¼W, Carbon	DRD139751
20R11	Res., 10k, ±5%, ¼W, Carbon	DRD139161
20R12	Res., 15k, ± 5%, 2W, Metal	DRG950121
20R13	Res., 180k, ±1%, ¼W, Metal	DRE939711
20R16	Res., 3.9k, ±5%, ¼W, Carbon	DRD139521
20R17	Res., 220k, ±5%, ¼W, Carbon	DRD139791
20R18	Res., 33k, ± 5%, ¼W, Carbon	DRD139681
20R21	Same as 20R17	
20R22	Res., 2.2k, ± 5%, ¼W, Carbon	DRD139461
20R25	Res., 18k, ± 5%, ¼W, Carbon	DRD139631
20R26	Res., 82k, ±5%, ¼W, Carbon	DRD139741
20R27	Res., 180, ± 5%, ¼W, Carbon	DRD139961
20R31	Res., 1.8k, ± 5%, ¼W, Carbon	DRD139441
20R32	Res., 39k, ± 5%, ¼W, Carbon	DRD139701
20R33	Res., 5.6k, ± 5%, ¼W, Carbon	DRD139541
20R34	Res., 82k, ± 1%, ¼W, Metal	DRE939701
20R35	Res., 15k, ±1%, ¼W, Metal	DRE939341
20R36	Res., 2.2 μ, ±5%, 1W, Metal	DRG940311
20R37	Res., 33k, ±1%, ¼W, Metal	DRE939091
20R38	Same as 20R34	
20R41	Same as 20R11	
20R42	Res., 10 μ, ± 5%, 1W, Metal	DRG940321
20R44	Same as 20R13	
20R45	Res., 4.7k, ±1%, ¼W, Metal	DRE939471
20R46	Res., 2.7k, ±1%, ¼W, Metal	DRE939651
20R47	Res., 10k, ±5%, ¼W, Carbon	DRD135071
20R51	Res., 200k, Var., 1.5W, Cermet	DRV350211
20R52	Res., 100k, ±1%, ¼W, Metal	DRE939191
20R53	Same as 20R52	
20R54	Res., 200k, Var., 0.2W, Carbon	DRV146851
20R55	Same as 20R14	
20R56	Same as 20R52	
20R57	Same as 20R13	
20R61	Same as 20R13	
20R62	Res., (20k, 20k), 0.05W, Carbon	DRV131421
20R63	Res., 470, ± 5%, ¼W, Carbon	DRD139371

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
20D1	Diode, 1S953	DDD010821
20D2	Diode, SM-05-20FRZ	DDD021721
20D4	Diode, HVT-30S	DDD021421
20D5	Same as 20D2	
20D6	Same as 20D2	
20D12	Same as 20D1	
20D26	Same as 20D1	
20D32	Same as 20D1	
20D33	Same as 20D1	
20D34	Same as 20D1	
20D41	Same as 20D2	
20D42	Same as 20D2	
20D43	Same as 20D2	
20D44	Same as 20D2	
20Q1	Transistor, 2SC2334L	DTR137621
20Q20	Transistor, 2SC1815GR	DTR139011
20Q30	Transistor, 2SA1015Y	DTR119011
20Q40	Same as 20Q20	
20Q61	Same as 20Q20	
20Q62	Same as 20Q30	
20IC20	IC, HA17458	DIC613511

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
20J1	Connector, M31-M87-15	DCN034551
20J3	Connector, M36-M87-02	DCN034601
20J4	Same as 20J3	
20J11	Same as 20J3	
20J12	Same as 20J1	
20J21	Same as 20J3	
20J22	Connector, M31-M87-10	DCN034531
20J23	Same as 20J3	
20P1	Connector, M33-15-30-114P	DCN034741
20P3	Connector, M36-02-30-114P	DCN034851
20P4	Same as 20P3	
20P11	Same as 20P3	
20P12	Same as 20P1	
10P21	Same as 20P3	
20P22	Connector, M33-10-30-114P	DCN034721
20P23	Same as 20P3	
20T1	High VoltageTransformer, FS-34442	DCL220351
20U1	High Voltage Unit, MSL3587A	DES050563
20V41	Neon Bracket Lamp, NL235	DLP025171
20F10	Fuse, FSA-1	DFU020141
	Fuse Holder, FSA-1	DSK060141

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
POWER SUPPLY & CALIBRATOR		
21C1	Cap., 1000p, ±20%, 3kV, Cer.	DCC171831
21C11	Cap., 100 μ, ± 20%, 25V, Elect.	DCE229071
21C21	Cap., 1000p, ±10%, 150V, Poly.	DCF241311
21C31	Cap., 33 μ, ±20%, 16V, Elect.	DCE229011
21C32	Cap., 4700 μ, ±20%, 16V, Elect.	DCE920711
21C41	Cap., 100 μ, ±20%, 160V, Elect.	DCE960161
21C42	Cap., 4.7 μ, ± 20%, 250V, Elect.	DCE270401
21C51	Cap., 1000 μ, ±20%, 63V, Elect.	DCE945121
21C52	Cap., 10 μ, ±20%, 100V, Elect.	DCE259011
21C61	Cap., 2200 μ, ±20%, 35V, Elect.	DCE930321
21C62	Same as 21C61	
21C65	Cap., 0.01μ, +80%~–20%, 50V, Cer.	DCC139501
21C71	Cap., 22 μ, ±20%, 25V, Elect.	DCE229041
21C75	Same as 21C71	
21R11	Res., 2.2, ±5%, ¼W, Carbon	DRD138881
21R12	Res., 2.7k, ±5%, ¼W, Carbon	DRD139481
21R13	Res., 6.8k,± 5%, ¼W, Carbon	DRD139561
21R14	Res., 500, Var., 0.3W, Cermet	DRV412021
21R15	Res., 820, ±5%, ¼W, Carbon	DRD139941
21R16	Res., 60, ±0.5%, ¼W, Metal	DRE239111
21R17	Res., 1k, ±5%, ¼W, Carbon	DRD134831
21R21	Res., 6.8k, ±1%, ¼W, Metal	DRE939331
21R22	Res., 10k, ±1%, ¼W, Metal	DRE939301
21R23	Same as 21R13	
21R24	Res., 4.7k, ±5%, ¼W, Carbon	DRD139151
21R25	Same as 21R12	
21R26	Res., 100k, Var., 0.3W, Cermet	DRV412131
21R27	Res., 270k, ±1%, ¼W, Metal	DRE939311
21R31	Res., 39k, ±5%, ¼W, Carbon	DRD139701
21R32	Res., 6.2, ±5%, 2W, Metal	DRS231081
21R34	Res., 50, Var., 0.5W, Cermet	DRV350201
21R41	Res., 82k, ±5%, ¼W, Carbon	DRD139741
21R42	Res., 1k,± 5%, ¼W, Carbon	DRD139141
21R43	Res., 18k, ±5%, ¼W, Carbon	DRD139631
21R44	Res., 82k, ±1%, ¼W, Metal	DRE939701
21R45	Res., 47k, ±1%, ¼W, Metal	DRE939371
21R46	Res., 12k, ±1%, ¼W, Metal	DRE939681
21R47	Same as 21R13	
21R51	Same as 21R41	
21R52	Res., 15k,± 5%, ¼W, Carbon	DRD139611
21R53	Res., 2, ±5%, 1W, Metal	DRS229051
21R54	Res., 33k, ±5%, ½W, Carbon	DRD149321
21R56	Same as 21R46	
21R57	Same as 21R13	
21R61	Same as 21R31	
21R62	Res., 0.68 , ±5%, 1W, Metal	DRS229041
21R63	Same as 21R62	
21R64	Same as 21R31	
21R65	Same as 21R41	
21R66	Same as 21R41	
21R67	Same as 21R42	
21R71	Same as 21R46	
21R72	Same as 21R46	
21R73	Res., 1.2k ±5%, ¼W, Carbon	DRD139421
21R74	Same as 21R13	
21R75	Same as 21R21	
21R76	Res., 3.9k, ±1%, ¼W, Metal	DRE939421
21R77	Res., 1k,Var., 0.3W, Cermet	DRV412031
21R78	Res., 5.5k, ±1%, ¼W, Metal	DRE939671
21D30	Diode, 1G4B1	DDD021031
21D40	Same as 21D30	
21D41	Diode, RD18EB	DDD031701
21D42	Diode, 1S953	DDD010821
21D43	Diode, SM-1M-02	DDD010771
21D50	Same as 21D30	
21D51	Diode, RD39EB	DDD031151
21D52	Same as 21D42	
21D53	Same as 21D43	
21D60	Same as 21D30	
21D61	Same as 21D41	
21D62	Same as 21D41	
21D71	Same as 21D42	
21D72	Diode, RD5.6EB1	DDD031141
21D73	L.E.D., TLG-104	DDD071111

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
21Q11	Transistor, 2SA1015Y	DTR119011
21Q12	Transistor, 2SC1815GR	DTR139011
21Q21	Transistor, 2SB861B	DTR125181
21Q22	Transistor, 2SD1137	DTR145711
21Q23	Same as 21Q12	
21Q24	Transistor, 2SC1061C	DTR130661
21Q25	Same as 21Q12	
21Q26	Same as 21Q12	
21Q31	FET, 2SK30A-Y	DTR210141
21Q32	Transistor, 2SA1015Y	DTR119011
21Q33	Transistor, 2SB857C	DTR125231
21Q34	Same as 21Q11	
21IC11	IC, HA17458	DIC613511
21IC12	IC, LM2902N	DIC613451
21IC30	IC, μPC14305H	DIC650021
21S1	Switch, SDG5P-E	DSW016531
21S40	Switch, SUJ12A	DSW014841
21PL31	Scale Illumination Lamp	DLP016092
21PL32	Same as 21PL31	
21PL33	Same as 21PL31	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
21T1	Power Transformer, C546888	DCL210992
21F1	Fuse, FSA-2	DFU020151
	Fuse Holder, FH033	DSK065361
21J10	Connector, M31-M87-12	DCN034541
21J11	Connector, M36-M87-06	DCN034641
21J12	Connector, M31-M87-10	DCN034531
21J13	Connector, M36-M87-04	DCN034621
21J17	Same as 21J10	
21J21	Connector, S-17220 # 04	DCN093521
21J30	Connector, M36-M87-02	DCN034601
21J33	Same as 21J30	
21P10	Connector, M33-12-30-114P	DCN034731
21P11	Connector, M36-06-30-114P	DCN034891
21P12	Connector, M33-10-30-114P	DCN034721
21P13	Connector, M36-04-30-114P	DCN034891
21P17	Same as 21P10	
21P20	Connector, M33-04-30-114P	DCN034661
21P22	Connector, X-17213	DCN093511
21P25	Connector, CM-3	DCN013361
21P30	Connector, M36-02-30	DCN034871
21P31	Same as 21P30	
21P33	Same as 21P30	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
PRINTED CIRCUIT BOARDS		
	VERTICAL MAIN AMPLIFIER	KPN187841
	VERTICAL PRE–AMPLIFIER	KPN187941
	(Composed with Vertical pre-Amplifier, Vertical Positions and CH3 & CH4 Amplifiers)	
	A SWEEP GENERATOR	KPN188131
	B SWEEP GENERATOR	KPN188051
	POWER SUPPLY	KPN188251
	(Composed with Power Supply, Horizontal Switches and Calibrator)	
	H.V.POWER	KPN188341
	(Composed with CRT Circuit, CH3 & CH4 Attenuator and High-voltage Protector)	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
UNIVERSAL COUNTER 1~6		
C001	Cap., 47μ, ±20%, 35V, Elect.	DCE235091
C002 to C008		
	Cap., 100μ, ±20%, 25V, Elect.	DCE225181
C009	Cap., 0.1μ, ±20%, 63V, Poly.	DCF128301
C010	Cap., 10p, ±0.5p, 50V, Cer.	DCC231701
C011	Cap., 100μ, ±20%, 16V, Elect.	DCE225041
C012	Cap., 0.01μ, ±10%, 50V, Poly.	DCF120231
C013	Cap., 330p, ±5%, 50V, Cer.	DCC234901
C014 to C016		
	Same as C012	
C017	Same as C010	
C018	Same as C011	
C019 to C020		
	Same as C012	
C021	Cap., 1000p, +80% ~ −20%, 50V, Cer.	DCC151801
C022	Same as C012	
C023	Same as C009	
C024	Cap., 33μ, ±20%, 16V, Elect.	DCE225021
C025	Same as C009	
C026	Same as C010	
C027	Cap., 5~40p, Var., 250V, Cer.	DCV019751
C028	Same as C012	
C033	Same as C012	
C034	Same as C009	
C035	Same as C012	
C036	Same as C009	
C037	Same as C035	
C040	Same as C009	
C041	Same as C009	
C042	Same as C012	
C050	Same as C012	
C051	Same as C009	
C053	Same as C035	
C054	Cap., 0.47μ, ±20%, 200V, Poly.	DCF171131
C056	Same as C027	
C057	Cap., 47p, ±5%, 100V, Mica	DCM242751
C058	Same as C013	
C059	Same as C035	
C060	Same as C035	
C061	Cap., 470μ, +75%, ~ −10%, 25V, Elect.	DCE122901
C062	Same as C002	
C063	Cap., 2.2μ, ±20%, 50V, Elect.	DCE244531
C064	Same as C063	
C067	Cap., 1000p, ±10%, 250V, Cer.	DCC151801
C067A	Cap., 4700p, ±1%, 50V, Cer.	DCC132901
C068	Same as C067	
C069	Cap., 4200p, ±10%, 250V, Cer.	DCC152901
C070	Same as C063	
C062A	Cap., 470p, ±10%, 250V, Cer.	DCC151201
C301	Cap., 0.1μ, ±20%, 63V, Poly.	DCF128301
C302	Cap., 180p, ±5%, 50V, Cer.	DCC234301
C303	Cap., 100p, ±5%, 50V, Cer.	DCC234001
C304	Cap., 680p, ±5%, 50V, Cer.	DCC131601
C305	Cap., 10μ, ±20%, 35V, Elect.	DCE130501
C306	Cap., 47μ, ±20%, 16V, Elect.	DCE120651
C307	Cap., 470p, ±10%, 50V, Cer.	DCC131201
C308	Cap., 2p~10p, Var., 250V, Cer.	DCV019771
C309	Cap., 5p, ± 0.25p, 100V, Mica	DCM131311
C310	Cap., 33p, ± 5%, 50V, Cer.	DCC232841
C311	Cap., 470p, ±5%, 50V, Mica	DCM254211
C312	Cap., 100p, ± 5%, 50V, Cer.	DCC234091
C313	Cap., 68p, ±5%, 50V, Cer.	DCC233601
C314	Same as C301	
R001	Res., 39k, ±5%, ¼W, Carbon	DRD135211
R002	Res., 1k, ±5%, ¼W, Carbon	DRD134831
R003 R004		
	Same as R002	
R005	Res., 560, ±5%, ¼W, Carbon	DRD134771
R006 to R010		
	Same as R005	
R011	Res., 100, ±5%, ¼W, Carbon	DRD134591
R012	Same as R011	
R013	Res., 620, ±5%, ¼W, Carbon	DRD134781
R014	Same as R002	
R015	Same as R011	
R016	Res., 1M, ±1%, ¼W, Metal	DRE141551
R017	Res., 470k, ±1%, ¼W, Metal	DRE141471
R018	Res., 100, ±5%, ¼W, Carbon	DRD144591
R019	Res., 10k, Var., 0.3W, Cermet	DRV411991

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
R020 to R025		
	Same as R011	
R026	Res., 150k, ±5%, ¼W, Carbon	DRD135351
R027	Res., 330, ±5%,¼W, Carbon	DRD134711
R028	Res., 10k, ±5%, ¼W, Carbon	DRD135071
R029	Same as R028	
R030	Res., 120k, ±1%, ¼W, Metal	DRE131331
R031	Same as R030	
R032	Res., 3.3k, ± 5%, ¼W, Carbon	DRD134951
R033	Res., 100k, Var., 0.3W, Cermet	DRV412131
R034	Res., 2k, ±5%, ¼W, Carbon	DRD130901
R035	Same as R011	
R036	Same as R034	
R037	Same as R011	
R038	Res., 22k, ±5%, ¼W, Carbon	DRD135151
R039	Same as R038	
R040 to R043		
	Same as R011	
R045	Res., 2.2k, ±1%, ¼W, Metal	DRE130911
R046	Same as R019	
R047	Same as R045	
R048	Res., 10k, Var., 0.3W, Cermet	DRV131441
R049	Same as R048	
R050	Same as R028	
R051	Same as R028	
R052	Res., 100k, ±5%, ¼W, Carbon	DRD135311
R053	Same as R052	
R055	Same as R028	
R056	Res., 3.9k, ±5%, ¼W, Carbon	DRD134971
R057 to R064		
	Same as R052	
R066	Res., 390, ±5%, ¼W, Carbon	DRD134731
R067	Res., 10k, ±5%, ¼W, Carbon	DRD135071
R068	Same as R011	
R069	Same as R011	
R070	Res., 240, ±5%, ¼W, Carbon	DRD134681
R071	Same as R019	
R072	Same as R027	
R073	Same as R027	
R074	Same as R067	
R075	Same as R056	
R076	Same as R067	
R077	Same as R002	
R078	Same as R052	
R080	Same as R034	
R082	Same as R034	
R083	Same as R067	
R084	Same as R011	
R085	Same as R011	
R086	Res., 4.7k, ±5%, ¼W, Carbon	DRD134991
R087	Same as R086	
R089	Same as R067	
R090	Same as R011	
R091	Res., 100, ± 5%, ¼W, Carbon	DRD134591
R092	Same asR091	
R093	Same as R091	
R093A	Same as R011	
R095	Res., 1.5k, ±5%, ¼W, Carbon (Used SS-5710C/SS-5710D only)	DRD134871
R097	Res., 7.5k, ±1%, ¼W, Metal	DRE535701
R301	Res., 330,± 5%, ¼W, Carbon	DRD134711
R302	Res., 5.1k, ±1%, ¼W, Metal	DRE131001
R303	Res., 500, Var., 0.5W, Cermet	DRV415161
R304	Res., 39k, ±1%, ¼W, Metal	DRE131211
R305	Res., 22,± 5%, ¼W, Carbon	DRD134671
R306	Same as R305	
R307	Same as R305	
R308	Res., 2.7 ± 5%, ¼W, Carbon	DRD134931
R309	Res., 1k,± 5%, ¼W, Carbon	DRD134831
R310	Res., 10k,± 5%, ¼W, Carbon	DRD135071
R311	Res., 2.2k,± 5%, ¼W, Carbon	DRD134911
R312	Res., 13k, ±1%, ¼W, Metal	DRE131101
R313	Res., 7.5k, ±1%, ¼W, Metal	DRE131041
R314	Res., 1.5k, ±1%, ¼W, Metal	DRE130871
R315	Res., 15k, ±5%, ¼W, Carbon	DRD135111
R316	Res., 680, ±1%, ¼W, Metal	DRE130791
R317	Res., 10, ±1%, ¼W, Metal	DRE130351
D001 to D003		
	Diode, 1S4B1	DDD021011
D004	Diode, 1S953	DDD010051
D005 to D009		
	Diode, 1S1544A	DDD010801
D010	LED., TLR102	DDD070231

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
D011	Same as D010	
D012 to D027		
	Same as D004	
D028 to D031		
	Same as D005	
D301	Same as D004	
Q001	Transistor, 2SA711(S)	DTR115601
Q002	Transistor, 2SC1815-GR	DTR137781
Q003	Transistor, μ PA61A	DTR295181
Q004 to Q007		
	Transistor, 2SC1834	DTR131031
Q301	Same as Q002	
Q302	Transistor, 2SC1254	DTR130861
Q303	Transistor, 2SC1834	DTR131031
D001 to D008		
	LED., TLR312	DDD070151
IC001	IC, μPC14312H	DIC650031
IC002	IC, μ PC16305H	DIC650111
IC003	IC, μPC14305H	DIC650021
IC004	IC, F10116DC	DIC310201
IC005	IC, SP8629	DIC190431
IC006	IC, TC5026BP	DIC490801
IC007	IC, TC810CP	DIC630731
IC008	IC, SN74LS04N	DIC140051
IC009	IC, SN74LS86N	DIC140871
IC010	IC, SN74S00N	DIC140011
IC011	IC, SN74LS107N	DIC141061
IC012	IC, CD4098BE	DIC424081
IC013	IC, SN74S00N	DIC170011
IC014	Same as IC007	
IC015	Same as IC007	
IC016	IC, SN74LS08N	DIC140091
IC017	IC, SN74LS54N	DIC140551
IC018	IC, SN74LS51N	DIC140521
IC019	IC, ICM7216BIPI	DIC190441
IC020	IC, CD4081BE	DIC410711
IC021	IC, CD4069BE	DIC410621
IC022	IC, SN74LS27N	DIC140281
IC023	Same as IC008	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
IC301	Same as IC010	
IC302	Same as IC010	
IC303	Same as IC008	
IC304	Same as IC010	
IC305	Same as IC010	
IC306	IC, SN74LS123N	
IC307	Same as IC011	
S001	Push switch, KSD2-4-10MLDC	DSW014171
S002	Push switch, KSD5-10-10MLDC	DSW014181
S003	Push switch, KSD6-14-10ILDC	DSW014191
J001	Connector, 128-03-10-2815	DCN032031
J002	Connector, M31-M87-12	DCN034541
J003	Connector, M33-M87-06	DCN034591
J004	Connector, M31-M87-07	DCN034501
J005	Same as J001	
J006	Same as J001	
J007	Connector, BNC080	DCN040711
J008	Connector, M36-M87-02	DCN034601
J009	Same as J008	
J0010	Same as J008	
J0011	Connector, M33-M87-04	DCN034571
J0012	Same as J008	
J0012A	Connector, M31-C8-4	DCN034951
J0013	Same as J012A	
J0014	Same as J008	
P001	Connector, 129-03-10-281P	DCN032021
P002	Connector, M33-07-30-134P	DCN034791
P003	Same as P001	
P004	Connector, M33-06-30-114P	DCN034681
P005	Connector, M33-12-30-114P	DCN034731
P301	Connector, M33-12-30-134P	DCN034501
P302	Connector, M33-04-30-134P	DCN034761
FB001	Resistors-array, AHR-121JB	DFB171151
X301	Crystal Osc., 10MHz	DHF010331
T001	Power Transformer, FS-334002	DCL213041

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
F001	Fuse, FSA-0.2	DFU020111			
	Fuse Holder, S-N5053	DSK060141			
PB001	PRINTED CIRCUIT BOARD COUNTER CONTROL	KPN196821			
PB002	PRINTED CIRCUIT BOARD DISPLAY A	KPN197911			
PB003	PRINTED CIRCUIT BOARD ALARM	KPN197811			

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
DIGITAL MULTIMETER UNIT		
1C101	Cap., 100μ, ±20%, 16V, Elect.	DCE225041
1C102	Cap., 0.01μ, ±10%, 50V, Poly.	DCF120231
1C103 to 1C105		
	Cap., 10μ, ±20%, 50V, Elect.	DCE245061
1C106	Cap., 1000μ, ±20%, 16V, Elect.	DCE121001
1C107	Cap., 2.2μ, ±20%, 50V, Elect.	DCE244531
1C108	Cap., 0.022μ, ±10%, 50V, Poly.	DCF120271
1C109	Cap., 0.047μ, ±1%, 50V, Poly.	DCF120311
1C110	Same as 1C102	
1C111	Cap., 0.47μ, ±10%, 63V, Poly.	DCF128311
1C112	Cap., 0.22μ, ±10%, 250V, Poly.	DCF168071
1C113 to 1C115		
	Same as 1C102	
1C116	Cap., 0.047μ, ±20%, 600V, Poly.	DCF171131
1C117	Cap., 0.1μ, ±5%, 63V, Poly.	DCF128301
1C118	Cap., 470p, ±5%, 50V, Cer.	DCC235301
1C119	Cap., 22p, ±5%, 50V, Cer.	DCC232401
1C120	Same as 1C116	
1C121	Same as 1C111	
1C122	Same as 1C111	
1C123	Cap., 100p, ±5%, 50V, Cer.	DCC234001
1C124	Same as 1C107	
1C125	Same as 1C107	
1C126 to 1C128		
	Same as 1C102	
1C132	Same as 1C111	
1L101	Filter Coil	DCL151171
1L102 to 1L106		
	Filter Coil	DCL151161
1R101	Res., 220, ±2%, 1W, Metal	DRE153571
1R102	Res., 200k, Var., 0.5W, Cermet	DRV410241
1R103	Res., 8.9M, ±1%, ½W, Metal	DRE390531
1R104	Res., 900k, ± 0.5%, ½W, Metal	DRE243781
1R105	Res., 90k, ±0.1%, ½W, Metal	DRE240121
1R106	Res., 9k, ±0.1%, ½W, Metal	DRE240111
1R107	Res., 900, ± 0.5%, ½W, Metal	DRE243821
1R108	Res., 90, ± 0.25%, ¼W, Metal	DRE231411
1R109	Res., 9 ± 0.25%, 1W, W.W.	DRJ229411
1R110	Res., 0.9, ±0.25%, 2W, W.W.	DRJ239421
1R111	Res., 0.1, ±1%, 5W, W.W.	DRJ269421
1R112	Res., 470k, ±1%, ½W, Metal	DRE141471
1R113	Res., 100k, ±1%, ½W, Metal	DRE141311
1R114	Res., 110, ±1%, ¼W, Metal	DRE130601
1R117	Res., 100k, ±1%, ¼W, Metal	DRE131311
1R118	Res., 10, ±5%, ¼W, Carbon	DRD134351
1R119	Res., 4.7k, ±1%, ¼W, Metal	DRE130991
1R120	Res., 20k, ±0.5%, ¼W, Metal	DRE233691
1R121	Res., 100, Var., 0.3W, Cermet	DRV412001
1R122	Res., 1.74k, ±0.5%, ¼W, Metal	DRE234471
1R123	Res., 470k, ±5%, ¼W, Carbon	DRC135471
1R124	Res., 1M, ±1%, ½W, Metal	DRE141551
1R125	Same as 1R117	
1R126	Same as 1R118	
1R127	Same as 1R118	
1R128	Res., 100k, ±1%, ¼W, Metal	DRE131311
1R129	Same as 1R121	
1R131	Res., 3.3M, ±5%, ¼W, Metal	DRG330171
1R132	Res., 510k, ±5%, ¼W, Carbon	DRD135481
1R133	Res., 10M, ±5%, ¼W, Metal	DRG330231
1R134	Res., 10k, ±1%, ¼W, Metal	DRE131071
1R135	Res., 10.7k, ± 0.5%, ¼W, Metal	DRE234481
1R136	Res., 4.7k, ±1%, ¼W, Metal	DRE130991
1R137	Res., 500, Var., 0.3W, Cermet	DRV412021
1R138	Res., 150k, ±5%, ¼W, Carbon	DRD135351
1R139	Same as 1R119	
1R140	Res., 2.4k, ±5%, ¼W, Carbon	DRD134921
1R141	Res., 5.6k, ±5%, ¼W, Carbon	DRD135011
1R142	Same as 1R141	
1R143	Same as 1R141	
1R144	Same as 1R140	
1R145	Same as 1R128	
1R146	Res., 22k, ±5%, ¼W, Carbon	DRD135151
1R147	Same as 1R137	
1R148	Res., 910, ±1%, ¼W, Metal	DRE130821
1R149	Res., 100, ±5%, ¼W, Carbon	DRD134591
1R150	Same as 1R149	
1D103	Diode, RD5.1EB	DDD030571
1D104	Diode, S2VB10	DDD022831
1D105	Diode, 1S953	DDD010051

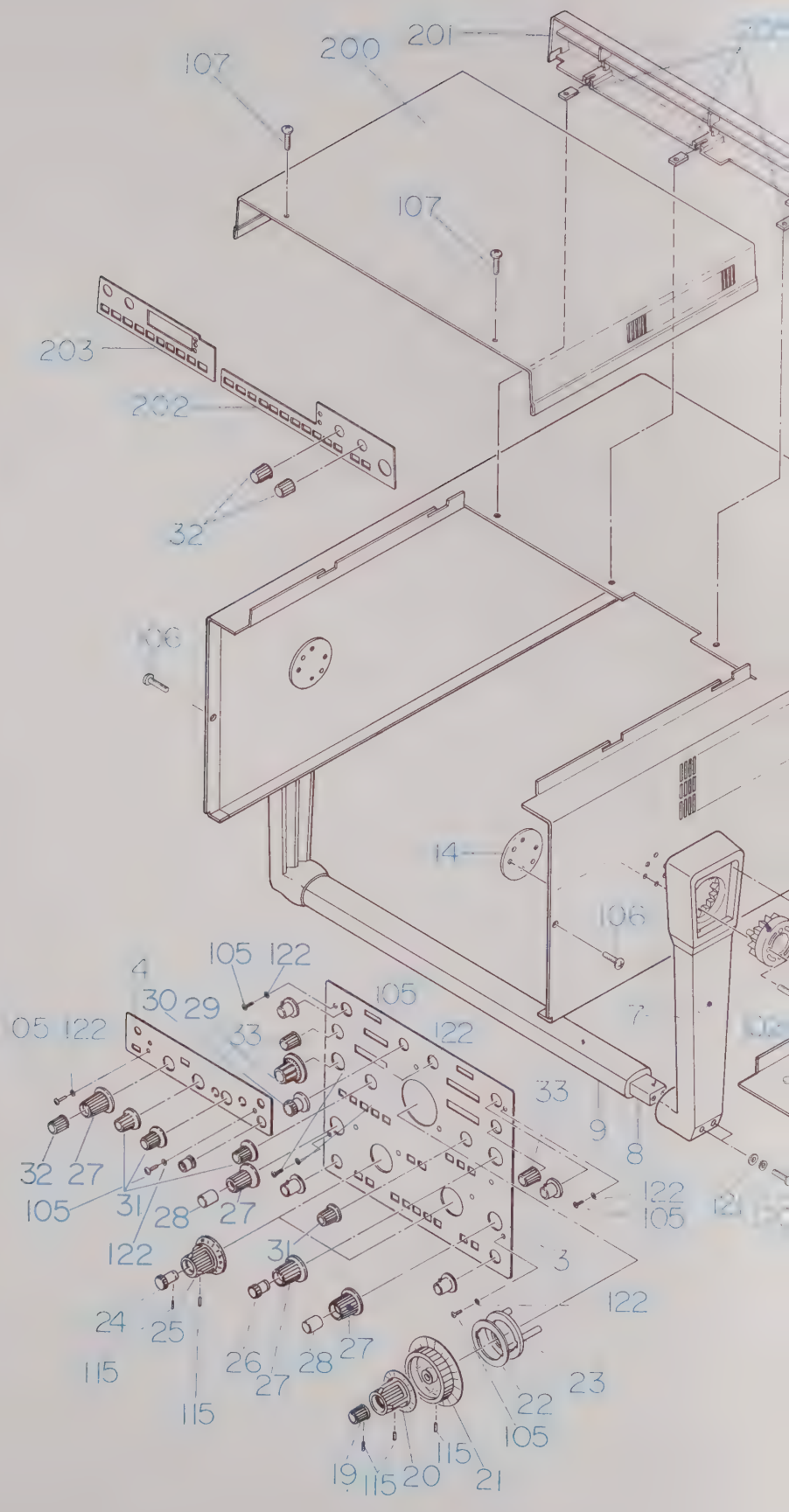
CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
1D106	Diode, 1S1544A	DDD010801
1D107	Same as 1D106	
1D108 to 1D110	Same as 1D105	
1D111	Same as 1D103	
1D115	Same as 1D105	
1D116	Same as 1D105	
1D117	Same as 1D106	
1D118	Same as 1D106	
1Q101	Transistor, 2SD612K	DTR145811
1Q102	Transistor, 2SC1815-GR	DTR137781
1IC101	IC, CP-3024	DES030321
1IC102	IC, ICL7660CPA	DIC641721
1IC103	IC, TL061CP	DIC613761
1IC104	IC, 7107CPL	DIC641711
1IC105	IC, 9491BJ	DIC690141
1S101	Push-switch, KSD4-14-10MLDB	DSW014211
1S102	Push-switch, KSD6-30-10ILDB	DSW014201
1RL101	Relay, MZ-5HS	DKD026781
1RL102	Reed Relay, LR1A-05B	DKD060271
1J101	Connector, M31 C8-4	DCN034951
1J102	Same as 1J101	
1P101	Connector, 129-03-10-281p	DCN032021
1FB101	Resistors-array, AHR-472JQ	DFB017161
1FB102	Same as 1FB101	
1FB103	Same as 1FB101	
1F101	Fuse, FSA-0.5	DFU020131
1F102	Fuse, FSA-2	DFU020151
1X101	Crystal Osc., KF-38P, 40kHz	DHF011821
1Z101	Surge-Absorbor, DSA-222L	DFU065581
1Z104	Varistor, TNR102K005	DDD060291
1Z105	Same as 1Z104	
1PB101	PRINTED CIRCUIT BOARD, 3.5DMM CONTROL	KPN196121
1PB103	PRINTED CIRCUIT BOARD, SHIELD BOARD	KPN197611
1PB104	Same as 1PB103	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
DIGITAL MULTIMETER DISPLAY B		
2C129	Cap., 1000p, +80%～−20%, 1kV, Cer.	DCC162731
2C130	Same as 2C129	
2C131	Same as 2C129	
2R151	Res., 1k, ±1%, ¼W, Metal	DRE535491
2R152	Same as 2R151	
2R153	Res., 1k, 5%, ¼W, Carbon	DRD134831
2I101	LED., TLR313	DDD070221
2I102	Same as 2I101	
2I103	Same as 2I101	
2I104	LED., TLR314	DDD070341
2D112	LED., TLR102	DDD070231
2D113	Same as 2D112	
2D114	Same as 2D112	
2Z105	Varistor, TNR102K005	DDD060291
2PB102	PRINTED CIRCUIT BOARD, DISPLAY B	KPN197711

NOTES

Mechanical Parts List and Illustration

INDEX NO	NAME & DESCRIPTION	Q'ty	IWATSU PART NO
1	COVER, upper	1	KBA512931
2	COVER, lower	1	KBA513051
3	PANEL A, front	1	KPA141121
4	PANEL B, front	1	KPA141311
5	PANEL, rear		KCM059821
6	ACCESSORY BAG	1	KLT021721
7	HANDLE, arm	2	KCM059431
8	HANDLE, bar	1	KMM198011
9	COVER, handle	1	KCM059731
10	COVER, handle arm	2	KCM059521
11	GEAR, stater	2	KCM059611
12	SPRING, handle arm	2	KSR012611
13	STOPPER, handle arm spring	2	KBA508121
14	FIXED METAL PLATE, stater gear	2	KBA512521
15	NAME PLATE B, serial number	1	ARA002711
16	NAME PLATE, line voltage range	1	KRA103621
17	FOOT, rubber, 16 ϕ	4	KGM007931
18	RH-3 x 10A	4	MSQ930223
19	N101220SR	1	KCM060811
20	A301540DGA	1	KCM060611
21	A471560DGA	1	KCM060521
22	TIMING PANEL	1	KPA142121
23	TIMING PANEL SUPPORT	1	KCM061811
24	N111230SRP	2	KCM060911
25	A301760DGA	2	KCM060711
26	PS KNOB	1	KCM066211
27	S181580DGA	4	KCM061001
28	PUSH BUTTON	2	KCM061611
29	MULTI-DIAL (electric part)		
30	K141360SGP	2	KCM061511
31	K141360SG	4	KCM061411
32	K101160	1	KCM061111
33	K101160SG	2	KCM061211
102	KD(+)3 x 18S	8	MKD130181
103	KP – 3 x 12S		MKP130121
105	KT – 2 X 4B		MKT220042
106	KT – 3 x 8B		MKT230082
108	KT – 3 12B		MKT230122
115	HL – 3 x 3		MHL130039
120	SW–3S		MSW130001
121	W–3S		MWW130001
122	NYLON W–2 (DM-7100)	6	KPL102411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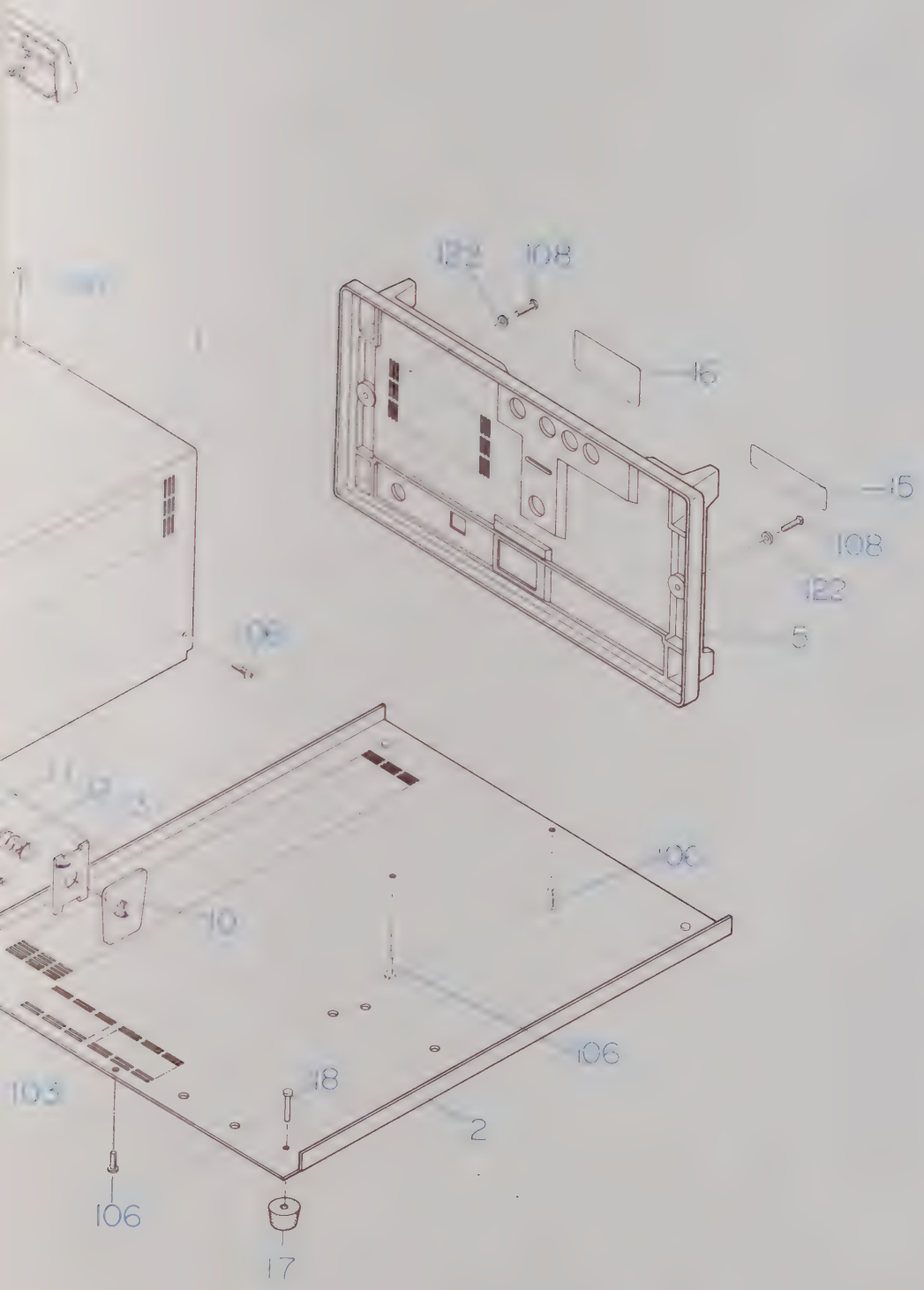
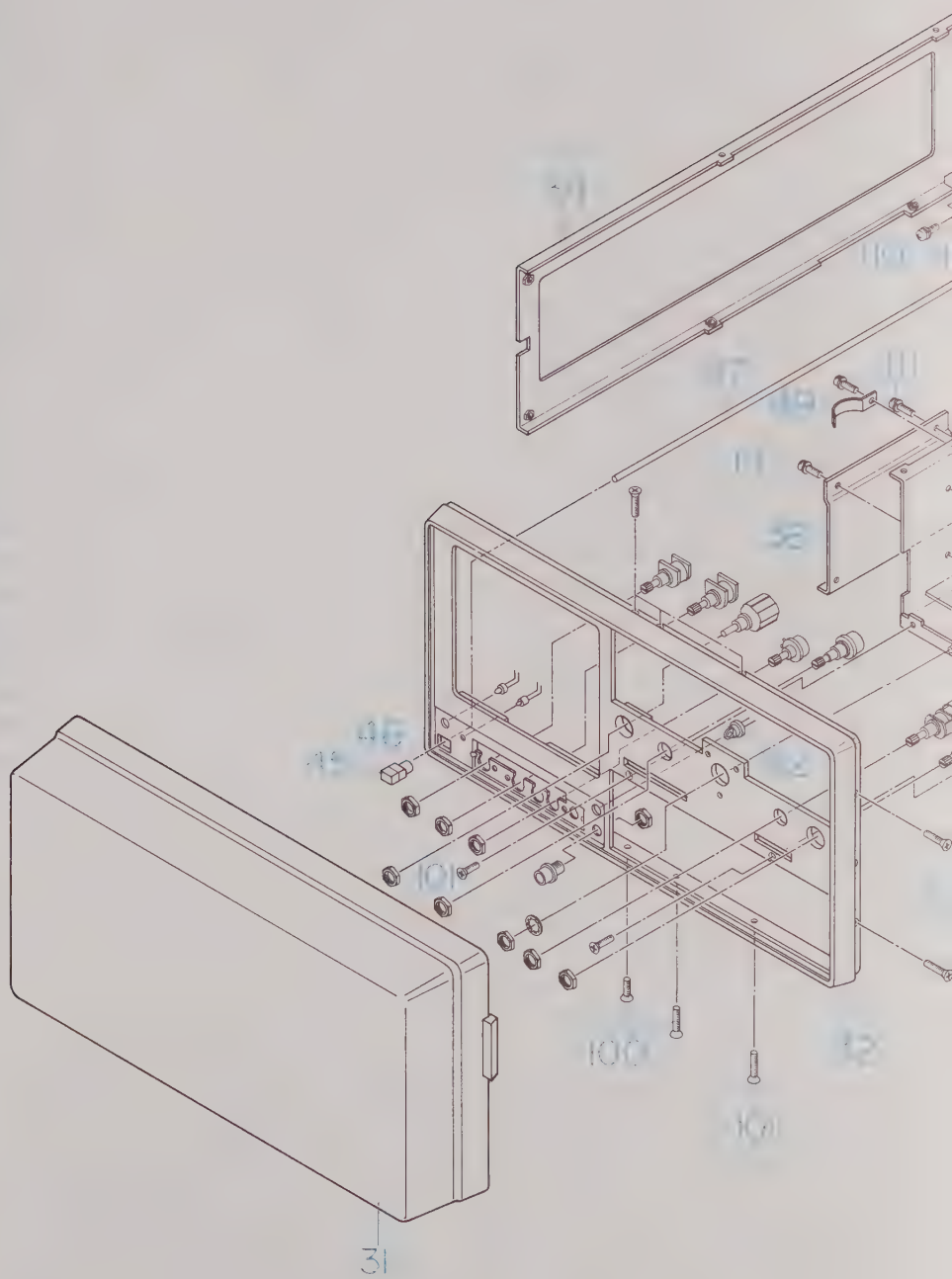


Figure 9-1

INDEX NO	NAME & DESCRIPTION	Q'ty	IWATSU PART NO
34	COVER, panel	1	KCM059921
35	SUB PANEL, front	1	KPA141841
36	CHASSIS	(1)	KBA516061
37	FRAME	1	KBA513751
38	SUB PANEL, rear	1	KPA142251
39	CRT SHIELD PLATE	1	KBA516831
40	CASE, high voltage		KBA516921
41	SEAT PLATE, transformer	1	KBA516721
42	STOPPER, transistor	2	KBA516411
43	SILICON RUBBER, heat-dissipater		
44	SEAT PLATE, CP	1	KBA526711
45	SEAT PLATE, line voltage selector	1	KBA526611
46	SEAT PLATE, INLET	1	KBA526511
47	PS KNOB CI, POWER		KCM061911
48	JOINT	1	KCM006621
49	ROD, power switch	1	KMM198311
50	INSULATE COUPLING	1	KCM006521
51	SPRING		
52	GUIDE, printed circuit board	3	MZT900381
53	BAND		MHK000961
55	CLAMP, DKN-05	1	MHK001331
69	BUSHING KG-024	1	KBU000501
82	TERMINAL, CAL	1	DTA010871
85	CP OUTPUT TERMINAL	1	KPS009511
86			
100	KD – 3 x 6S		MKD130061
101	KD – 3 x 8S		MKD130081
110	SM1 – 3 x 6	20	MSM130061
111	SM1 – 3 x 8CT		MSM130081
114	SM5 – 3 x 8		MSM530081
116	HL – 3 x 4		MHL130049
117	KP – 3 x 10		MKP130101
120	SW – 3S		MSW130001
121	W – 3S		MWW130001
125	WS09(1.5)62B 0	1	KMM199611
126	STAY RB1.6 08 09 30A0	3	AMM627811
127	STAY		KMM198211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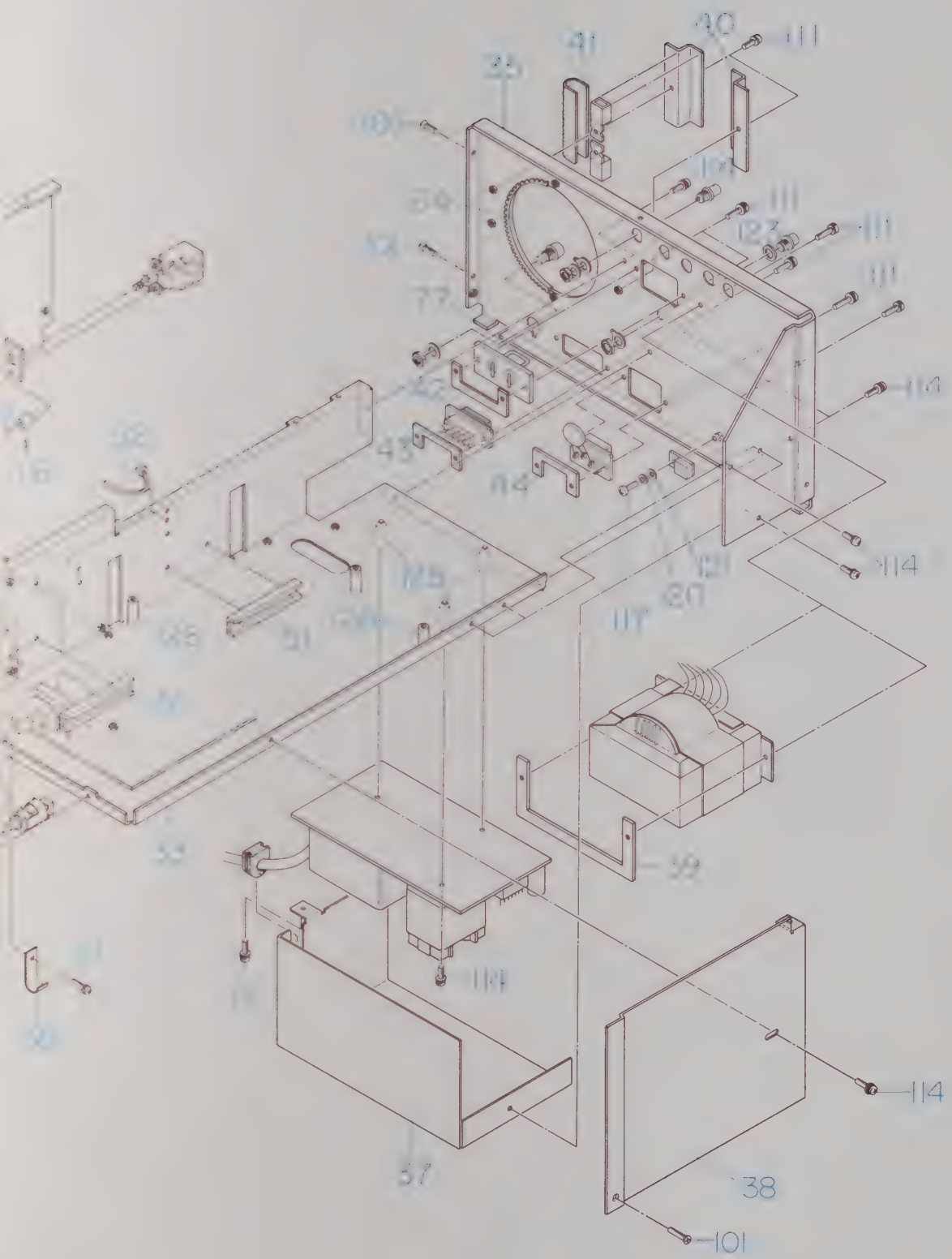
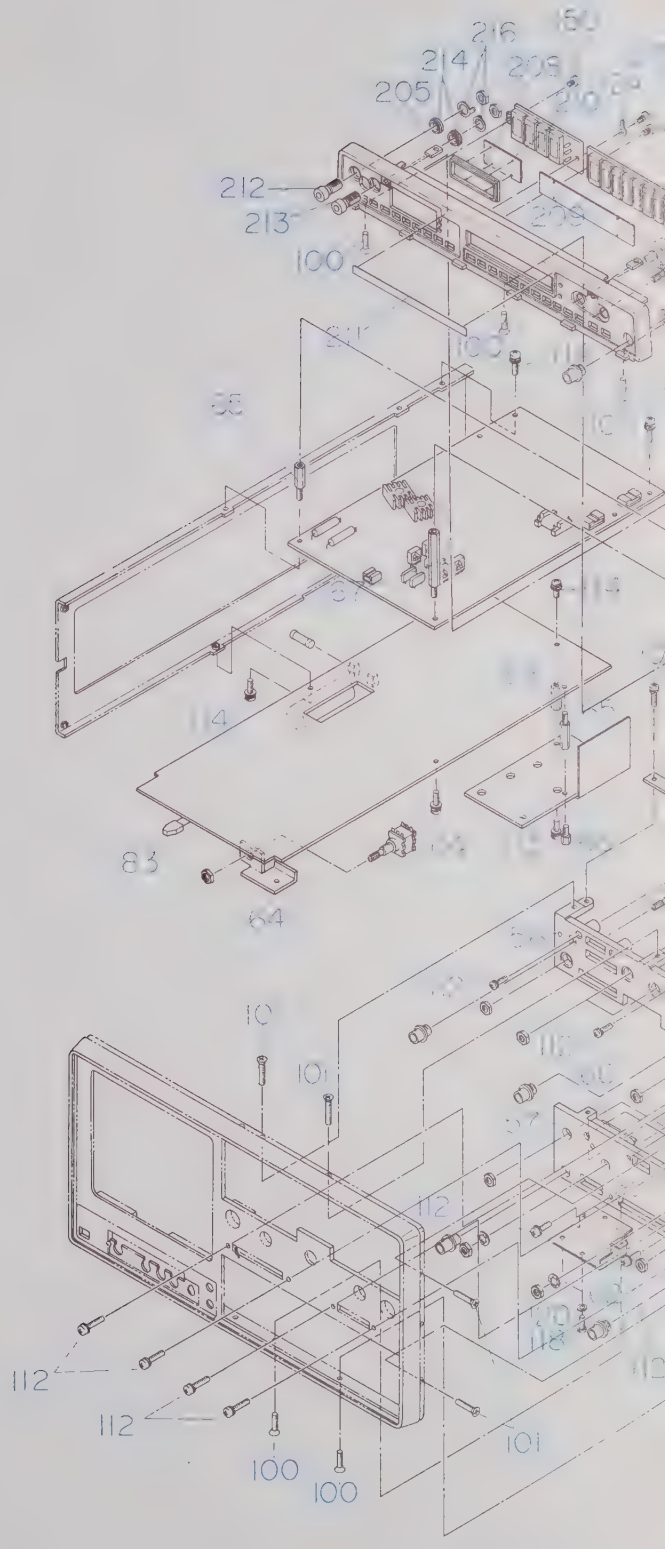


Figure 9-2

INDEX NO.	NAME & DESCRIPTION	Q'ty	IWATSU PART NO
51	SPRING, ground	2	KBA520821
56	SUB PANEL, H	1	KPA141931
57	SUB PANEL, V	1	KPA142021
58	ATT SHIELD PLATE F	1	KBA513831
59	ATT SHIELD PLATE E	2	KBA514031
60	ATT SHIELD PLATE A	1	KBA516631
61	ATT SHIELD PLATE C	1	KBA516331
62	ATT SHIELD PLATE B	1	KBA516531
63	ATT SHIELD PLATE D	1	KBA516231
64	ATTACHMENT, PCB of power supply	1	KBA529711
65	STAY A, screw	1	KMM198611
66	STAY B, screw	1	KMM198721
67	STAY C, screw	8	KMM198811
68	SBH (5.5) (18.5) 30B0	1	KMM107511
83	PS KNOB D1	37	KCM062011
84	PS KNOB D2		
86	Lug 10.2 ϕ	4	KPS004311
100	KD – 3 x 6S		MKD130061
101	KD – 3 x 8S		MKD130081
109	SM1 – 2.6 x 6CT	30	MSM126061
111	SM1 – 3 x 8CT		MSM130081
112	SM1 – 3 x 12CT	10	MSM130121
113	SM5 – 3 x 6	50	MSM530061
114	SM5 – 3 x 8		MSM530081
118	KD – 2.6 x 4S		MKD126041
120	SW – 2.6S		MSW126001
	SW – 3S		MSW130001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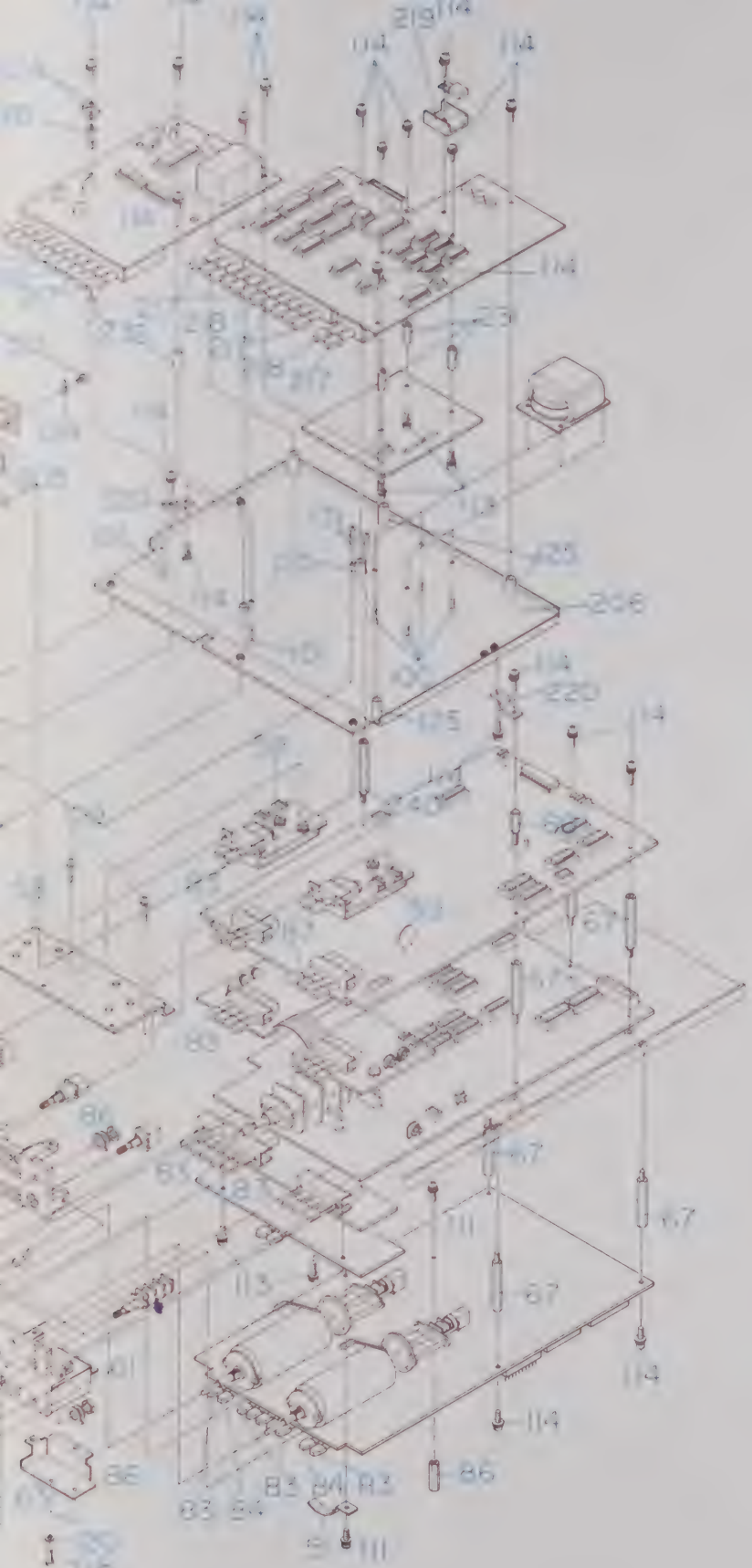
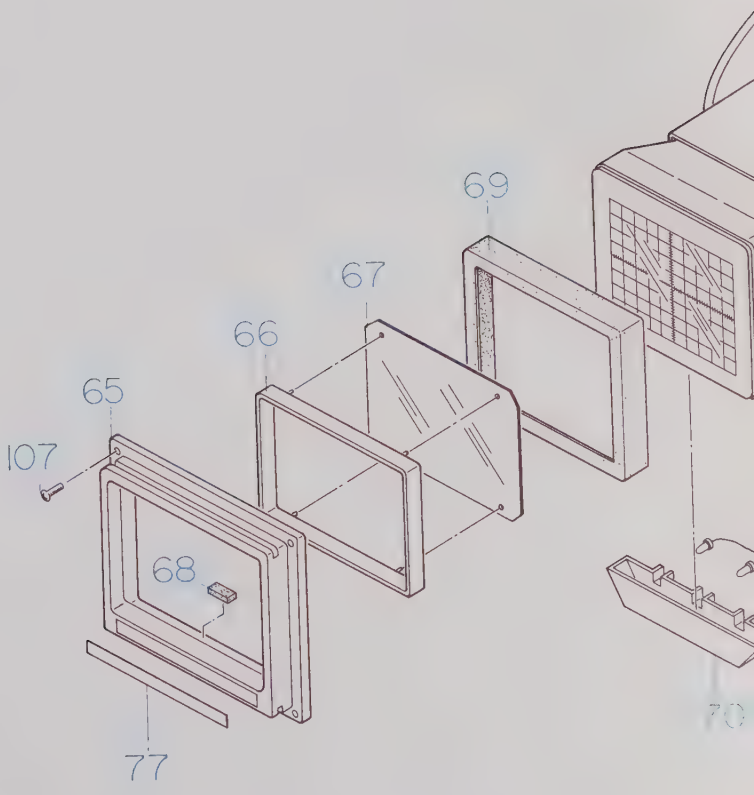


Figure 9-3

INDEX NO	NAME & DESCRIPTION	Q.ty	IWATSU PART NO
53	BAND		MHK000961
70	BEZEL B2,	1	KCM060321
71	BEZEL B2,	1	KCM060411
72	FILTER FRAME B2	1	KPL014811
73	CUSHION, CRT	1	KGM009631
74	SCALE ILLUM PLATE	1	KCM056111
75	STOPPER, Filter	1	KPL013411
76	NAME PLATE, title, SS-5711	1	KRA103221
77	SHIELD CASE A	1	KBA513221
78	SHIELD CASE B	1	KBA513311
79	SUSPENSION A, CRT shielded case A and B	2	KBA513421
80	SUSPENSION B, CRT shielded case A and B	1	KBA513521
81	CRT FIX BAND	1	KBA513621
82	CRT FIXED RUBBER	1	KGM009511
104	KP (+) 3 x 25S	1	MKP130251
107	KT – 3 x 10		MKT230102
113	SM5 – 3 x 6	50	MSM530061
114	SM5 – 3 x 8		MSM530081
120	SW – 3S		MSW130001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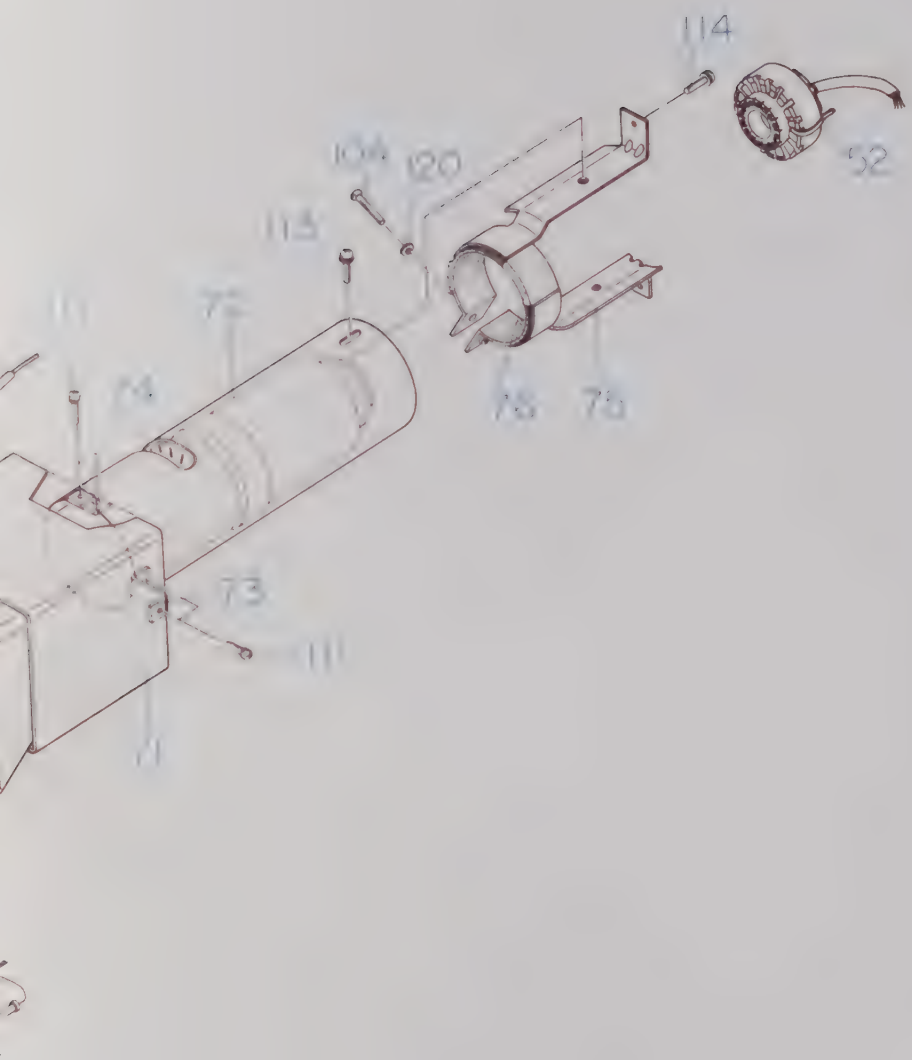

Figure 9-4

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